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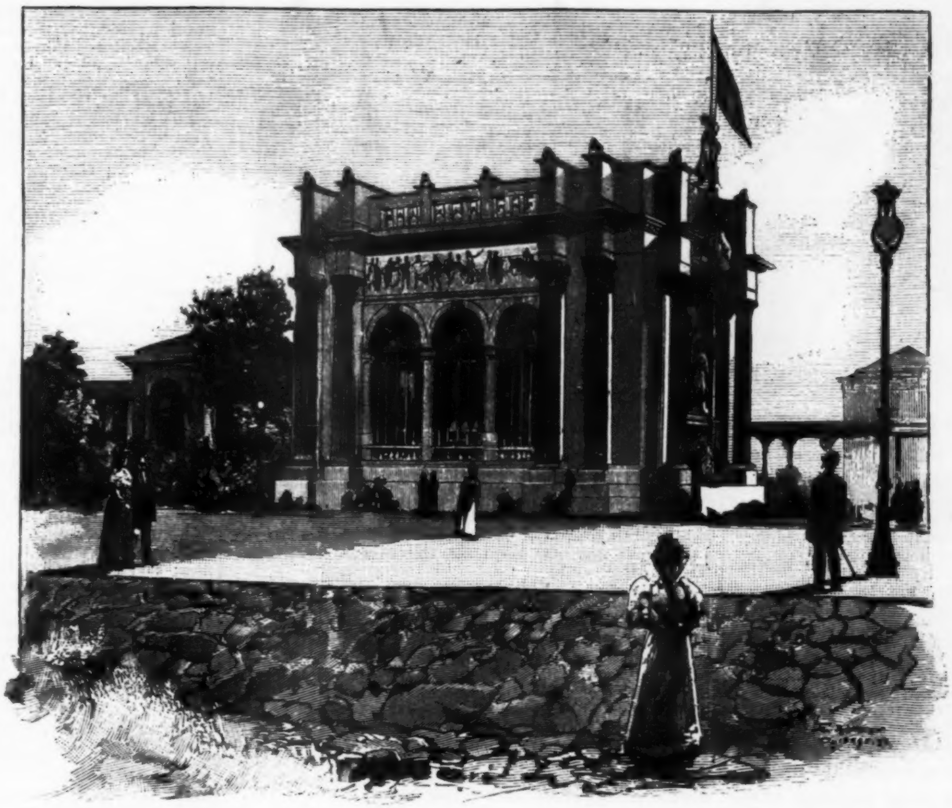
THE WORLD'S COLUMBIAN EXPOSITION—THE INTERNATIONAL QUARTER.

THE northern part of Jackson Park is devoted entirely to the individual States of the North American Union, but the northeastern portion has an international character. Along the sandy shore of the great blue Lake Michigan, and on a peninsula that projects out between North Pond and the broad middle lagoon, geography is turned topsy-turvy. Turkey lies between Brazil and Nicaragua, and Hayti between East India and New South Wales, while Ceylon borders on France and Norway on Costa Rica. About two dozen states and colonies have erected their separate buildings here, devoting them especially to national exhibits. The architecture of each building indicates the country by which it has been constructed. By far the largest and finest of these buildings is that of the German empire. Her two great rivals at the Exposition, England and France, are represented in the international quarter by their special government buildings, but here, as in the different buildings of the Exposition, they are outdone by the Germans, much to the surprise of the Americans, who were not prepared for such a fine display of German art and industry. The main front of the French government building—rich renaissance style—is turned toward the immense Lake Michigan. Two slightly projecting side pavilions inclose a court that is ornamented by a beautiful bronze fountain and garden plots. One of these pavilions contains the interesting exhibit of the city of Paris, which has already been seen at former expositions; and in the other are relics, documents and weapons associated with the memory of Lafayette, that French hero who offered the aid of his sword to General Washington during the American war of independence, and whose memory now forms a connecting link between the two nations, France and America.



THE WORLD'S COLUMBIAN EXPOSITION—BUILDING OF THE FRENCH GOVERNMENT.

The Swedish building is very peculiar, with its curious pavilions, cupolas and little towers, representing the Swedish architecture of the sixteenth and seventeenth centuries. The building is shown in the annexed illustration. Sweden and Norway are represented separately in Jackson Park, and as Sweden has no historical connection with America, the artistically arranged exhibit relates to the present industries, arts, objects of interest in this country. Gold and silverware, Swedish glass and porcelain, products of mines, stuffs, etc., fill the spacious central room, which is decorated with pretty pictures and portraits, while the corner pavilions contain artistic interiors, with Swedish furniture, carpets, curtains, embroideries, etc.

Opposite the Swedish building rises a great pavilion with the colored carving and decoration of Hindostan—not a government building, nothing more than an Indian tea house with a well filled bazar, in which dark-skinned, turbaned Hindoos sell all kinds of bronze, ivory and wooden wares; colored Indian embroideries, stuffs, shawls and carpets are stacked up and find a ready market. Un-

THE WORLD'S COLUMBIAN EXPOSITION—BUILDINGS OF SWEDEN AND INDIA.

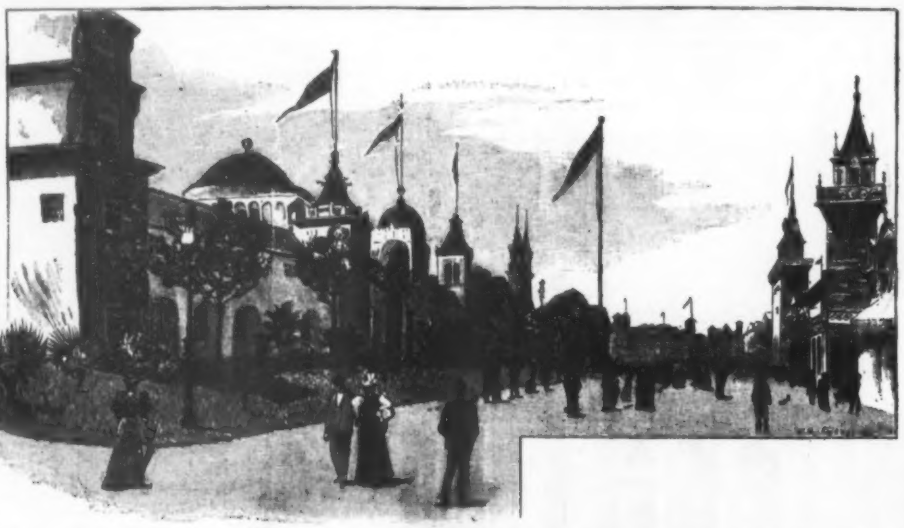
fortunately, all these products show the influence of European culture, and the curious grafting of this on the old Indian is not considered an improvement.

In the narrow space between the Swedish and Indian buildings rush the trains of the elevated railroad, which the Americans have built after the model of elevated roads used formerly only in New York and Chicago. The tracks rest on light steel pillars, about three feet above the surface of the ground, and on these glide the trains filled with tired visitors of the Exposition. These trains, which are driven by electricity, form the only extensive means of transportation in the grounds. Here we have one of the strange contrasts of the Exposition; in the midst of a land in which transportation facilities play so important a role and have been so greatly extended, there is absolutely no railroad except this elevated railroad. And how much they are needed in an exposition where the visitors have to walk distances of from three to five miles. To be sure, there are gondolas and little steamers on the lake, but they run over very short routes, and the roller chairs, which are rolled over the gravel walks by university students (?) in uniform, cost for a single ride 50 cents! A narrow gauge road of the Decauville system, such as they had at the Paris Exposition, would carry millions! And these are the practical Americans!

THE AMERICAN QUARTER.

The most northern of the great buildings of the International Exposition in Jackson Park is the Palace of Fine Arts, the beautiful facade of which, decorated with Ionian columns and crowned by a cupola, rises directly from the mirror-like surface of a quiet little lake, called "North Pond." Broad steps lead to the high terraces surrounding the palace, and from here the visitor is offered a very extensive and charming view of the Exposition grounds, with the gigantic snow-white buildings, their towers and cupolas, numerous monuments, fountains and triumphal arches. In no place in the world can one see so many and such large structures. The entire northern part of Jackson Park, about 125 acres, is occupied by about fifty buildings, of different sizes and styles of architecture, suited to the different climates, and to different needs; an exhibition in itself, which gives one an excellent opportunity of becoming acquainted with the American continent. While the American citizens have entered the international competition with their goods, the different State governments tried to set a picture of the natural wealth of the industrial products and of the administrative departments of their particular States before the eyes of the foreigners, partly for the purpose of showing their progress and partly with the object of attracting settlers. The autonomy of the individual States is much greater than the people of the Old World are inclined to think. In the wide expanse of the Union the conformation of the ground, the climate, and all the conditions of life are similar, so that there is very little noticeable difference between the inhabitants of the different States, but they cling to their native States and allow no guardianship of the government of the Union, although they defend it jealously against foreigners and hold loyally to their allegiance. This individuality of the States is expressed in a striking way at the Exposition, by the buildings that they have erected; the necessary amounts of money—in many States, $1,000,000—were appropriated without objection by the legislatures. Each State tried, as far as possible, to stamp its building with the characteristics of its culture, and while the buildings of old New England States, for example, were erected in the Dutch or Colonial style of the earlier centuries, the Southern States turned, very appropriately and with much good taste, to the colonnades of their chief cities and their city halls or to the wide verandas and balconies of the planters' houses on the sugar and cotton plantations. Florida erected a reproduction of dingy old Fort Marion, at St. Augustine; Indiana a Gothic castle; Texas surrounded its high airy villa with palms and cacti which are found so abundantly there. The largest and most remarkable building is that erected by California, a reproduction of the old Spanish mission San Gabriel, which, shaded by orange trees and high grapevines, is still dreaming its existence away in the southern part of the State. Our artist, C. Limmer, has given us a good reproduction of this building with its little towers and arches. To increase the resemblance to the original and make the visitor feel that he has been transported in spirit to the golden land, the garden around the mission was planted with palms and orange and lemon trees, and on the balustrade of the flat roof and terraces are cacti and palmetto trees, and only the Spanish monks are lacking to make the illusion perfect.

The interior of the building brings the visitor back suddenly from the time of the old Spanish mission to the practical but no less beautiful present. In the spacious halls are piles of the luxurious products of nature in this blessed land, the delicious fruits, pears and apples as large as a fist, immense clusters of grapes, whole mountains of juicy oranges, peaches and garden produce; and oil paintings show the beauties of the Yosemite Valley, the Sierra Nevada and the landscapes of Calaveras and Mariposa Groves, with their gigantic sequoias, the largest and tallest trees on the earth.



THE WORLD'S COLUMBIAN EXPOSITION—STREET WITH STATE BUILDINGS.

The California building to the left, and the Michigan and Indiana buildings to the right.

The State of Washington, like California, has shown specimens of its natural products at the Exposition, making its building entirely of immense tree trunks from its extensive forests. The lower part is formed of trees from 98 feet to 130 feet long, and a yard in diameter. In front of the building a pole nearly 168 feet high has been erected. That Washington—not to be confounded with the capital city of the same name on the Potomac—has besides its immense forests fruitful lands under cultivation can be seen by a visit to the building, in which a large grain farm, with fields, farm houses, granaries and workmen are represented in miniature.

While the State buildings mentioned above are used especially for exhibition purposes, those for Indiana and Michigan, shown in the right of the illustration, contain only club and reception rooms for the citizens of the respective States, and offices for the State commissioners. This is true of the majority of the other State buildings; and in erecting them an attempt was made to give a clear idea of the natural resources of the respective States, by using the native marbles, woods, etc.; and in decorating, the products of native talent, as furniture, pictures, glass decoration, wood carving, etc., have been utilized. In many States single rooms contain historical exhibitions with relics, standards, documents, etc., belonging to the early history of the great land.—Ernst v. Hesse-Wartegg, *in Illustrirte Zeitung.*

THE WORLD'S COLUMBIAN EXPOSITION—THE BUILDERS IRON FOUNDRY EXHIBIT OF 12-INCH BREECH-LOADING RIFLED MORTARS.

As a part of the system of coast defense determined upon in 1886, the United States government decided to use what are officially termed "12-inch breech-loading rifled mortars, cast iron body, steel hooped, 14½ tons." Seventy-three of these guns have been ordered at a total cost of about $600,000.

The mortars in appearance very closely resemble the steel breech-loading rifles made by the United States Navy Department, with the exception of their length, which in the rifles is about thirty times the diameter of the bore, and in the mortars only ten times.

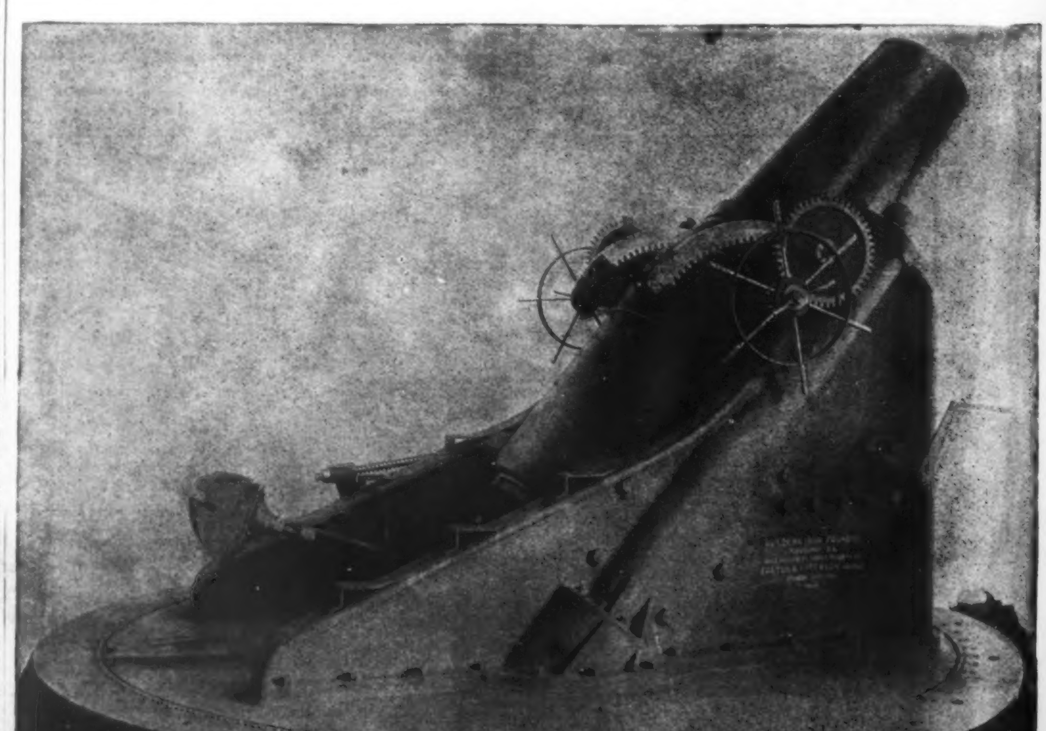
The cast iron bodies have a 12-inch bore, are 129 inches long and 31½ inches diameter, and the diameter over the steel hoops, which are shrunk on the bodies in two rows, is 42½ inches.

The specifications in the contract call for the castings for the bodies to be made from charcoal pig and to be cast vertically, breech downward; to be cooled by the circulation of water through the core, according to the Rodman process. Test specimens cut from both muzzle and breech ends of the mortar to have an elastic limit of about 17,000 pounds and a tensile strength between 30,000 and 37,000 pounds per square inch, or nearly double the strength of ordinary cast iron; one-fifth of the entire casting to be cut off for a shrink or sinking head.

The metal is also tested for specific gravity and hardness. The latter is a comparative test, and is made by forcing a standard steel pyramid into the metal and noting the depth to which it sinks under a given pressure.

The metal is melted in what is known as an air furnace, and the iron, being separated from the fuel, is more uniform and homogeneous, and the results more reliable than could be obtained with the ordinary cupola. About six hours are required to completely fuse it and from two to six hours longer to bring the metal to the proper state before pouring. The amount of coal consumed is about 14,000 pounds, or 37 per cent. of the weight of metal, which is nearly four times the amount of fuel required by an ordinary cupola.

The iron being tapped off flows through a long trough of fireclay directly from the furnace into the mould. As soon as the piece is cast, water is kept constantly circulating through the core, and the cooling at once commences. The top of the casting is covered with charcoal and a charcoal fire is built in the pit around the outside of the iron flask to keep the



THE WORLD'S COLUMBIAN EXPOSITION—THE BUILDERS IRON FOUNDRY EXHIBIT OF TWELVE INCH BREECH-LOADING RIFLED MORTARS.

exterior from cooling too rapidly. In about twenty-four hours the core is removed and the water turned directly into the bore of the casting for a day or two longer. The castings are made at the rate of one a week.

The casting is next placed in a gun lathe, which is of heavy build with a long boring-bar attachment instead of a tail-stock. The gun is held and driven by a large chuck on the face-plate, and the other end of the casting runs in a semicircular bearing or steady rest. The boring-bar has no rotary movement, but is fed toward the face-plate and carries a reamer-like cutter-head which enlarges the hole by several cuts to 11·8 inches. Meanwhile, ordinary turning tools are turning down the chase or forward taper and parting off the test disks and shrink head. The parting tools are run in nearly to the bore, the gun body is removed from the lathe and the disks broken from the casting by wedge and sledge. The hole is next enlarged to within 0·1 inch of the final diameter.

The steel hoops preparatory to shrinking are faced at the ends and bored to 31·5 inches diameter, 0·003 being the allowed variation from exact size.

The outside of the body is now accurately turned to a varying diameter slightly larger than the inside of the hoops to be shrunk thereon. This difference is called the "shrinkage" and it varies along the entire length to be hooped, the purpose being to place each of the hoops under nearly equal tension. As might be supposed, the diameter of the bore is slightly decreased when the hoops are shrunk on.

Air and city gas are mixed in about the proportions of three to one by an injector, and the flames play directly against the hoop, both inside and out, and heat it to about 500° Fah., or to a point where a certain minimum gauge will enter, but not far enough beyond to admit another gauge 0·015 inch larger, the total expansion being about 0·09 inch in a hoop. When heated, the hoop is slipped over the gun and up to its proper place, when, by means of the hooping press, a force of 100 tons is exerted to make a tight joint between it and the one immediately in front. A plane of water from a "sprinkling ring" is then allowed to play on the forward portion of the hoop, which soon contracts enough to grip the body. The plane of water is then moved slowly backward until the entire hoop is cold. The closeness of these joints may be inferred from the fact that after the exterior is turned they can seldom be detected. The exterior of the first row or "A" hoops is now turned down as carefully as was the body, the "B" or second row of hoops shrunk on in a similar manner, and the entire exterior is turned to the finished diameters. The hoops are so placed as to break joints.

The next step in construction is the fine boring, which must be between 12·000 and 12·003 inches diameter, and straight enough to allow a test cylinder 11·997 inches diameter and 42 inches long to easily slip through the entire length of the bore of the gun.

Next comes the rifling. Few operations in machine shop practice require as much care as the rifling of a cannon, since so much is at stake. There is no part of the most expensive steam engine but can be replaced in case of an accident during the manufacture, but here the results of months of labor may be entirely spoiled by a false cut. The body would be ruined and the steel hoops encircling it would be worthless. The necessity for extra care both in the design and operation of the rifling machine is apparent. Extra care is enjoined upon the operator, and mechanical contrivances are provided for instantly stopping the machine if any detail gets out of alignment.

Sixty-eight grooves are cut, 0·379 inch wide and 0·07 inch deep, and these grooves have an "increase pitch" varying from one turn in 25 calibers to one in 40; the object being to avoid a too sudden initial rotation of the shot when fired. The next operation is the threading, which is done with a special machine.

To load, the breech block is unlocked by turning a crank and then pulling out the breech-block and connecting parts on to the tray, which is then swung round out of the way. The shot is raised by a sort of crane and shoved in, and the powder follows in a bag. The tray is then swung back to its first position and the breech block is run in by turning the translating roller-crank handle, and locked by the revolving gear handle. This uncovers the vent, where a primer is inserted, and the mortar is ready to aim and fire.

In these mortars about 80 pounds of powder will produce an initial pressure of some 28,000 pounds per square inch, and give a muzzle velocity of 1,200 feet per second to a shell of 630 pounds. This will insure a range of about six miles at 45° elevation. The shell or hollow steel shot contains about 30 pounds of fine powder. Its front end is turned to a curve called the "ogival" which form offers the least resistance to the air, and its back end contains a soft metal collar, which, when forced into the rifling grooves, gives it the required rotary motion. The ingenious primer which fires the explosive in the shell is also placed at the back end of the shell. It does not move from its place when the shot is fired, but is projected forward against a fulminating cap when an object is struck.

These mortars are mounted on carriages very similar to cannon carriages, except that the recoil takes place 50° from instead of in the horizontal plane.

It is proposed to distribute them along our seaboard in groups of sixteen, to have them shielded from the enemy's ships by high earth embankments, and to fire them simultaneously by means of electricity.

The Builders Iron Foundry was incorporated in 1853 and succeeded the old High Street Furnace, which had been a leading foundry since 1822.

The works are situated on Codding, High and Dodge Streets, Providence, R. I., and the foundry is among the best fitted for heavy work in New England, and one of the largest devoted to general jobbing.

The castings for some of the largest hydraulic presses, mining machinery, water and sewage pumps and pumping engines in the country have been made here, and an excellent reputation attends the building or architectural castings from which the company derives its name.

The machine, smith and pattern shops occupy a line of brick buildings four hundred feet in length, with a total floor space of thirty thousand square feet.

Some of the machine shop tools are unusual. One of the large lathes will receive between centers a piece 5 feet in diameter and 70 feet long.

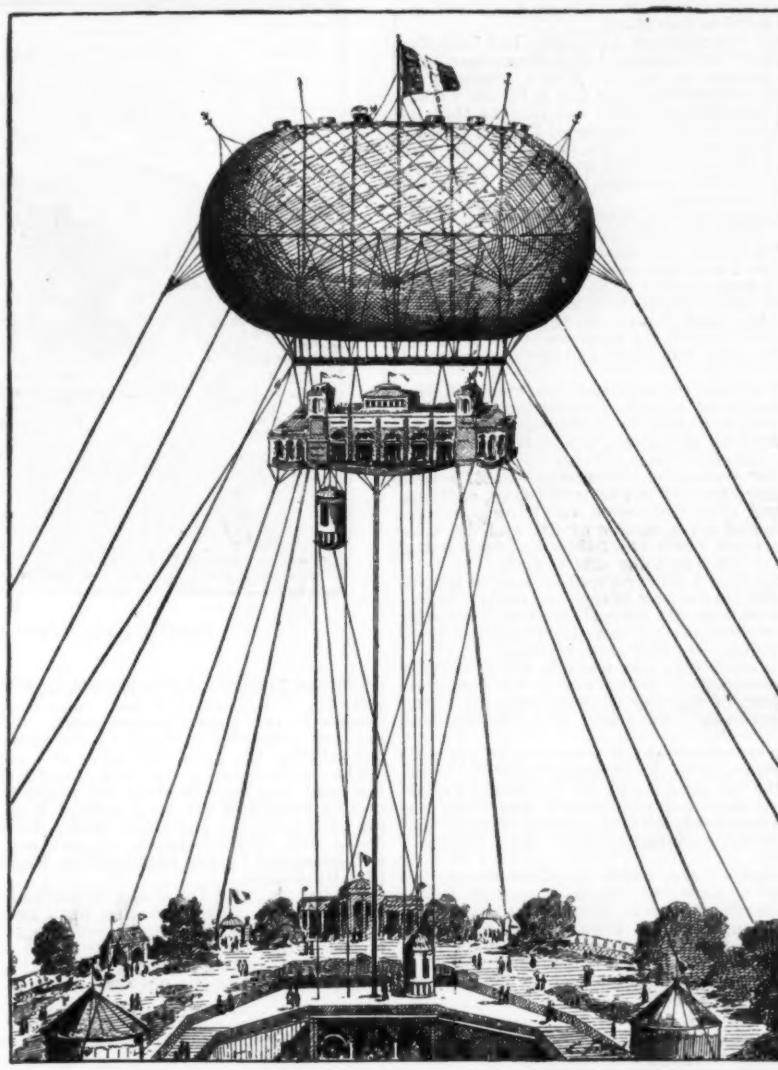
THE AERIAL CASTLE OF THE ANTWERP EXPOSITION.

EVER since the Eiffel tower caused the curious of both hemispheres to flock to the Universal Exposition of 1889, every country has been seeking a "hit" that will insure the success of its future expositions. The Americans, although renowned for the oddness of their imagination, have not succeeded in finding the piece without rival at Chicago, and blame their inventors rather than the isolation due to the seas for the uncertainty of their success. Now we have the Belgians announcing their "find" for the Antwerp Exposition in 1894. The fruit of their watchfulness is the aerial castle, which we reproduce herewith from the official documents. It is an immense captive balloon with tight compartments constructed by Engineer Tobiansky.

The following is the legend that accompanies the picture:

The collective balloon consists of two hemispheres and three cylindrical compartments of triple Chinese silk.

Capacity (together), 2,592,765 cubic feet.



THE AERIAL CASTLE OF THE ANTWERP EXPOSITION.

Surface (together), 100,000 square feet.

Ascensional force with illuminating gas, 130,376 pounds.

Weight of the balloons, castle, all accessories, and 150 persons, 78,364 pounds.

Excess of ascensional force, 52,012.

Length of the balloons, 256 feet.

Diameter, 125 feet.

The balloon is connected with the earth by four vertical cables of 55,000 pounds breaking charge each.

Communication is had through two balloon elevators capable of carrying from 10 to 15 persons every six minutes and held in a vertical direction by guide cables.

The breaking charge of the elevator cables is 52,800 pounds, while its weight, inclusive of 15 persons, does not exceed 5,500 pounds.

The aerial castle is constructed of steel tubes and bamboo and is covered with Chinese silk and wire gauze.

It will soar to heights varying from 650 to 1,600 feet, according to the force of the wind at different altitudes. The castle can be let down entirely to the ground in 30 minutes. Its length is 98 feet and its surface is 2,150 square feet.

After these technical data and a few details designed to increase the confidence of visitors, after stating that the castle is capable of resisting immovably a hurricane of 220 pounds pressure, but that, for prudence sake, in case of a tempest announced by the Royal Observatory, the castle will be let down to the earth in less than 30 minutes, the programme goes into ecstasies over the object and utility of the invention. Among the attractions offered are astronomical observations and optical telegraphy, which, however, are not recreations universally indulged in.—*L'Illustration.*

THE JAPANESE CRUISER YOSHINO.

THE Japanese cruiser Yoshino has been constructed by the firm of Sir W. G. Armstrong, Mitchell & Co., Limited, from designs by their naval architect, Mr. Philip Watts.

This vessel, *Engineering* says, is generally similar in design to the 9 de Julio, which was built by the same firm for the Argentine Republic, and whose trials we reported in February last. The Yoshino has, however, attained a greater speed than that attained by the 9 de Julio, and she is at the present time the fastest cruiser afloat. She is 350 ft. long, 46½ ft. broad, and has a displacement of about 4,000 tons. Her armament consists of four 6-in. quick firing guns, eight 4·7-in. quick firing guns, twenty-two 3-pounder quick firing guns, and five torpedo guns.

Lord Ravensworth, in his presidential address at the recent meetings of the Institution of Naval Architects, drew attention to this vessel, and stated that the firm contemplated attaining a speed of 23 knots. This was fully realized in the trials of July 11, when the speed attained as the mean of four runs on the measured mile, with and against the tide, in accordance with the practice of the British Admiralty, was 23·031 knots. The actual speeds recorded were as follows:

	Knots.
First run against the tide	22·642
Second run with the tide	23·377
Third run against the tide	22·571
Fourth run with the tide	23·762

The programme on July 11 last consisted of a series of progressive trials to establish a curve of speed for the ship, the information thus obtained being required for further trials which have yet to be made, including a six hours' trial with natural draught, when a speed of upward of 21 knots is contemplated. The speeds at which trials were made, and corresponding revolutions and horse power observed, were 12, 16¼, 20¼, 22·1, and 23·03 knots, the latter being accepted as the official forced draught trial of the ship. The power corresponding to the higher speed was approximately 15,000. The machinery, which has been constructed by Messrs. Humphrys, Tennant & Co., worked throughout the day in the most satisfactory manner, and without hitch of any kind.

Of the whole length of the Suez Canal, sixty-six miles are cuttings, fourteen were made by dredging through the lakes, and eight miles required no labor,

THE PORT OF BIZERTE.

AFTER Tunis, which celebrated the inauguration of its new port by splendid fetes, it is Bizerte whose port, thanks to the work accomplished, will be open some day to the ships of the entire world.

We saw this city seven or eight years ago. The canal that traversed it, widened by Agathocles in order that it might serve as a port, the sole communication with the lake, was poorly defended against the fury of the sea and was absolutely impracticable in the interior, its bottom being encumbered by sand and rocks. The wharves were in ruins, and the Mussulman decay was everywhere. The fisheries rendered the lake inaccessible.

A tongue of land, 700 or 800 yards in width, separated the lake from the sea to the east of Bizerte, outside of the port of Tunis. It is this isthmus that it was necessary to pierce in order to put it in communication in destroying some extremely productive fisheries. The idea was then conceived of removing these fisheries to the point of Sebra, which projects to some distance into the outer lake and forms a very pretty bay—an excellent roadstead, with sufficient depth and an incomparable shelter. The utilization of the surplus of the outer lake and of the lake properly so called will be unnecessary for the current use of the commercial port, whatever be the development that it may reach.

Bizerte, which the Arabs call Benzert, was known in antiquity by the name of Hippo Zaritus, and in the time of the Punic wars was a flourishing port, the objective of a hundred combats. It was there, too, that General Breart's division embarked.

Bizerte, from the remotest antiquity, had been the focus of a commercial movement that Mussulman negligence had allowed to perish. Was it necessary to leave a corner predestined to so fine a future unproductive and unexploited, under the pretext that its jealous neighbors would be displeased? No; certainly not. So, as long ago as 1886, Mr. Paul Cambur, who had instituted the protectorate government in Tunis, occupied himself with restoring to Bizerte at least a little of its antique valor.

It is from this epoch that date the first works of improvement. The utilizable portion of the sunken wharves was restored, the cleaning and dredging of the ancient canal and port were undertaken and our torpedo boats were enabled to enter Bizerte.

In 1887 two small steam dredgers were set to work to remove the sand banks of the bar; and, in order to better protect the entrance of the port, the old dilapidated jetty was raised and prolonged toward the east.

The effect of this prolongation was excellent, but still inadequate, and a new prolongation was soon added to it. So, in a short time, the entrance of the port was assured, in all seasons, to vessels drawing less than 10 feet. The result was striking.

In 1886 the movement of navigation was 267 vessels with 3,099 tons; in 1890 it rose to 363 ships, carrying 8,300 tons; and soon there were seen lying at the restored ancient wharves vessels of 300 and 400 tons where the smallest boats, the *londes* and *mahonnes*, were not always sure of being able to land.

But all these works, all these results made of Bizerte only an inferior port, a port of coasting trade. So the maritime service immediately made studies of the work necessary to convert Bizerte into an important port, capable of receiving ships of great tonnage.

A thousand soundings were made in 1889 in the part of the Lido designed for the passage of the new canal and in that part of the bay of Sebra situated in the axis of the said canal. They were found favorable to dredging.

There were recognized at the same time two important deposits of stone for the construction of the works in the sea—the Ain-Roumi and Djebet-Maklouf quarries. These studies and preliminary operations permitted of the uninterrupted continuation of works that are in reality but a continuation of those begun in 1886.

The great north jetty, which advances toward the east as far as 3,280 feet, where it reaches depths of 43 feet, is nearly finished. Founded upon the ancient mole of Kasbah, it is already protecting ships against the storms that, in these regions, come from the north and northeast.

A second jetty, likewise 3,280 feet in length, running north and south, is in course of construction. Its extremity, stopping at depths of 43 feet, will be located 1,376 feet from the extremity of the north jetty. It is here that will be the entrance of the outer port, a calm sheet of water, in which ships will be able to perform their evolutions at ease, and which will protect the new canal, whose axis lies exactly upon the channel of the outer port.

The new canal, which forms a communication between the lake of Bizerte and the sea, has been excavated for some months, and wharves are being established and dredging is being proceeded with. It is 197 feet in width at the bottom, and the dredging will give it a depth of 25 feet, thus rendering it accessible to the largest packet boats. As the inflowing and outflowing currents do not attain a dangerous velocity, the canal will serve as a port.

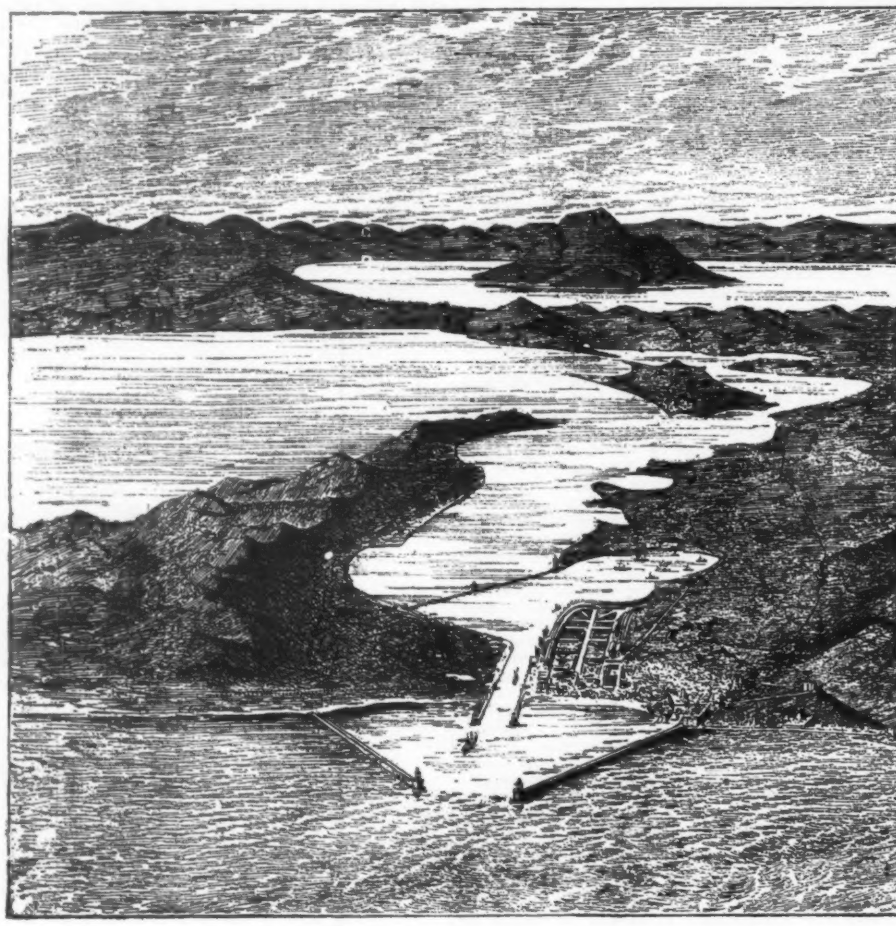
The maritime city, the new Bizerte, stands upon the land that extends along the north wharf—made ground formed of the spoil derived from the dredging of the canal. Landings, sheds, storehouses and docks will extend between the city and the canal, and be served by the railway from Bizerte to Tunis (the Djedeiada).

Toward the lake the canal debouches opposite the point of Sebra, which detaches itself from the north shore of the outer lake, and upon this point is to be erected a lighthouse, in the axis of the canal and of the pass of the outer port. This light will permit ships coming from the open sea to enter the port at the dead of night and go to anchor in the roadstead of Sebra, which offers depths of more than eighteen feet.

As the wharves and landings designed for commercial operations will extend along the canal itself, the port of Bizerte will present the oddity, unique without doubt, of being an outer port that will be also an inner port.

As the fisheries conceded to the port company afford a large revenue and contribute to the alimentation of Tunis, it was impossible to sacrifice them. The company has moved them back to the point of Sebra, where they constitute the closing of the bay of Sebra on the lake side.

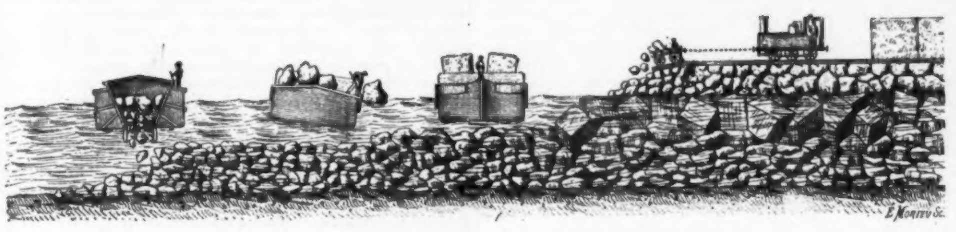
In sum, as well says Mr. Eugene Resal, the engineer of public works charged with the maritime services of Tunis, Bizerte is situated at the back of a gulf upon a bank running from northwest to southwest. A rectilinear canal of vast section, at right angles with the bank, passes to the southwest of the confines of the city and debouches on one side into the sea in a vast basin protected by two great jetties, and on the other side into the outer lake of Bizerte, where we find the deep bay of Sebra, a perfectly safe roadstead. An approachable port is in process of construction along the north shore of the canal, and a new French city is springing up as if by enchantment between the canal and the old Arabian city. The cost of this fine creation, the capitalized maintenance of the works and the terrible and inevitable unforeseen in matters of mari-



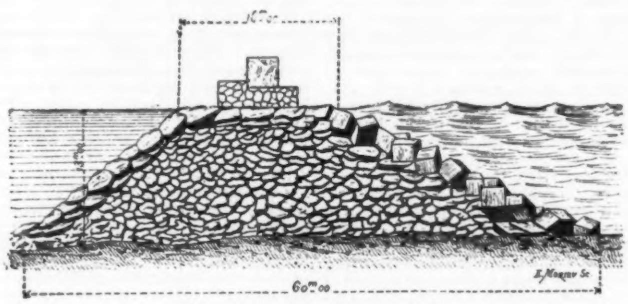
BIRD'S EYE VIEW OF THE PORT AND LAKE OF BIZERTE.

THE ANCIENT CANAL.

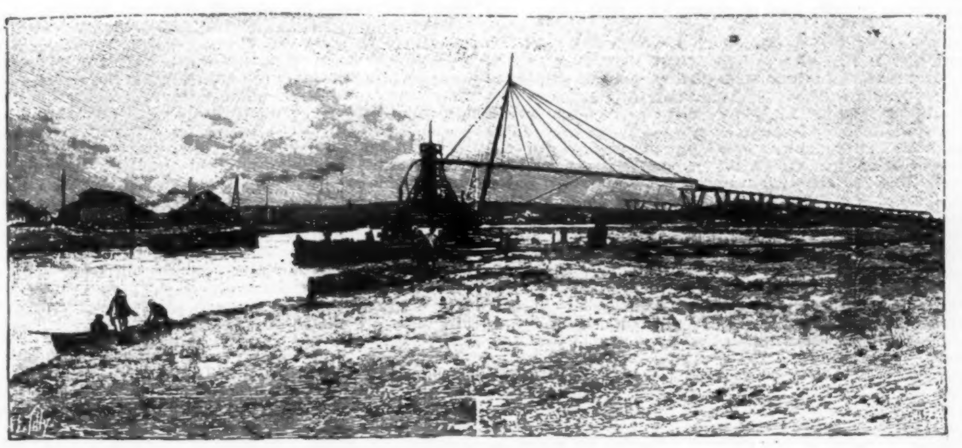
time works would have exceeded the resources of the small Tunisian budget. A combination permitted of reducing the weight of it. Messrs. Hersent & Couvreux requested and obtained the concession of the construction and exploitation of the port of Bizerte; then they made it the object of a special society, the



METHOD OF CONSTRUCTION OF A JETTY IN THE SEA.



SECTION OF THE JETTY.



DISPOSAL OF THE SPOIL.

Company of the Port of Bizerte. The state contributes to the execution of the works, which will finally belong to it, merely a subsidy of a million dollars and the profits derived from the fisheries, the fate of which is intimately connected with the new port.

Reduced to this figure, says Engineer Resal again, the sacrifice made by the state in the construction of the port of Bizerte may be considered as modest in view of the importance of the work. Not only is it proportionate to the resources of the budget, but also, by the very reason that it is limited and that the burden of the enterprise will fall solely upon the grantees, the sacrifice becomes, in a way, an advantageous one. Bizerte will necessarily become a stopping point for ships on their way to Chinese waters, an intense commercial movement will develop there and the duties of every kind that traffic will bring to the state will certainly constitute a splendid interest for the capital invested.

The working centers that have been created for the construction of the jetties and for the piercing of the Lido that separates the lake from the sea have been of a gigantic nature and have given Bizerte and its vicinity an extraordinary animation. The European population of the city has tripled in less than two years and the houses of a new city have grown up as if by enchantment.

Four steam cranes in the Ain-Roumi quarry, four locomotives and the cars necessary for the exploitation of the road that leads from this quarry to the jetty, two powerful dredgers capable of dredging 35,000 cubic feet per day, an elevator with a long chute emptying the spoil at a distance, numerous lighters and some boats (some with valves) for submerging the large blocks and three 100 and 200 horse power towboats have constituted the heavy *materiel* of the enterprise.

An important workshop, storehouses and workmen's houses have formed a true faubourg between the canal and the old city of Bizerte. Genuine villages of workmen's houses have been created at the quarries of Ain-Roumi and Djebel-Maklouf. The cost of material, installations, etc., has exceeded $400,000. The total cost of the work and its capitalized maintenance will certainly exceed $2,500,000. It may be said that, thanks to the proposition of the contractors, as well as to the patriotism and ingenuity of the regretted Resident General Massicault, Bizerte sees a magnificent future opening to it, and France, so poorly endowed on the Mediterranean side, is going to find an incomparable and valuable stopping point upon the Tunisian coast. —*L'Illustration.*

A STEAM CARRIAGE OF SIXTY YEARS AGO.

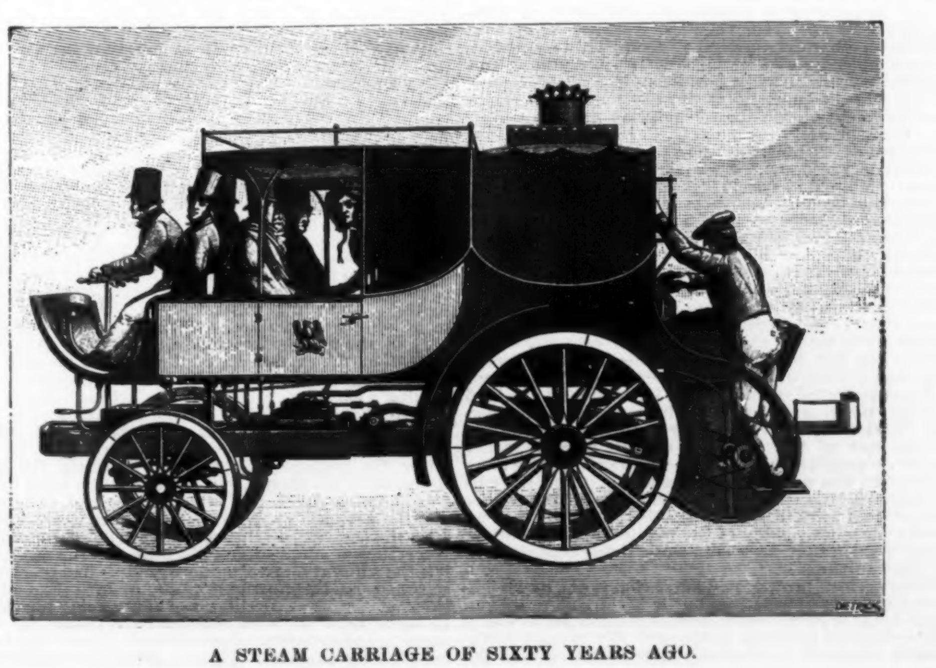
THE first inventor who conceived the idea of having recourse to steam for running a mechanical road carriage was Joseph Cugnot, a Frenchman. All treatises on mechanics have spoken of the steam trucks that Cugnot, more than a century ago, proposed to construct for the carriage of cannon and military material. The inventor, who had made some experiments at Brussels, went to Paris in 1763, and, after several years of researches, finally constructed a model of a steam carriage, which was submitted to the examination of General Gribeauval in 1769. A year afterward he constructed a definitive model whose operation left much to be desired. The apparatus was relegated to the Conservatory of Arts and Trades, where visitors can still see it. Cugnot's machine was a true tricycle, actuated by a direct-acting steam engine. The latter consisted of two vertical bronze cylinders into which the steam was introduced through a tube that was in alternate communication with the boiler, in order to receive the steam, and with the atmosphere, in order to free itself from the steam after the latter had produced its effect.

The bad impression produced upon the public by Cugnot's failure considerably retarded the discovery of locomotion by steam. We have to await the beginning of the century, in 1801, to find the models of the high-pressure steam engines of Trevithick and Vivian. These inventors succeeded in constructing a steam carriage for ordinary roads. Between the large wheels was situated the mechanism, above which was placed the carriage, exhibiting but a slight resemblance to a diligence.

We confine ourselves to the recalling of these old apparatus, which are very curious for the epoch at which they were experimented with. Our object is not to write the history of steam carriages from Cugnot to Serpollet, but to present to our readers a little known apparatus that we have found illustrated in an old print. It concerns a "Steam Carriage for Ordinary Roads, patented July 18, by Francois Macerone and J. Squire." This carriage is very well represented in a lithograph that we reproduce herewith, and which, in addition to the above title, includes the following legend:

This carriage has already run more than sixty leagues and continues to run every day, upon the most hilly roads (those of Harrow and Edgware, for example) without there being as yet any necessity of repair to the boiler or the mechanism. Its mean speed is six postal leagues per hour; but, on a level, it is made to run every day at the rate of eight leagues per hour. Its boiler is constructed according to a new principle, that renders dangerous accidents impossible.

We are unable to say whether or not the merits of this old steam carriage are somewhat exaggerated in the lines just quoted. We should have liked to find some completer data in the patent of July 18, 1833, but this patent does not exist at the Conservatory of Arts and Trades, where the director of the Bureau of Patents has made some researches at our request. The construction, none the less, merits notice. Behind the apparatus is seen a coal bunker and a blower, designed to quicken the draught of the smokestack.—*La Nature.*



A STEAM CARRIAGE OF SIXTY YEARS AGO.

THE IDEAL ENGINEERING EDUCATION.*

By Prof. WILLIAM H. BURR, of Columbia College, New York.

As no course of professional study can possibly fit any student for a complete and mature professional practice, it is a safe assumption that even "the ideal engineering education" cannot be expected to produce young engineers so mature in the exercise of all their professional functions that nothing is left for the years of subsequent practice to accomplish in the direction of education. I wish to emphasize this point at the outset, for the reason that many men engaged in practical duties of an engineering nature frequently, and perhaps usually, complain that, within their own experiences, young engineers almost invariably have failed to possess immediately that grasp of practical detail and well-balanced judgment which gives to the experienced practitioner the almost unconscious power of so perfecting plans and conducting operations as to perfectly control and utilize all indeterminate factors and blend them in proper proportion with the purely physical elements of the problem which lend themselves to exact treatment. It is true that young engineers have not acquired through their education those ripe powers which are the fruits of years of professional practice or of actual experience. The postulates of these very critics are enunciated from a vantage ground of middle life, or even later years, from which a clear view of their own earlier qualifications is quite obscured, either by present activities or by a failure to appreciate either the purposes or the scope of professional education. I do not maintain that these critics in practice are either many in number, or that they give a ruling tone to the consensus of professional opinion as to education in engineering; yet they constitute an existing type, and their strictures merit attention, since they accentuate the consideration of at least some of the principal fea-

* Read before the Engineering Congress, Chicago, 1893.

tures which should characterize an ideal engineering education. The fundamental motive of this criticism is not influenced by the fact that education, particularly professional education, creates nothing; that its functions are to draw out, to develop systematically and symmetrically those latent powers with which the individual is endowed, not in ripeness and maturity, but in condition only for growth. This indeed is, or ought to be, the purpose of all education, but it is particularly true of the ideal engineering education, or of any other professional education, since the latter requires the exercise of such functions under conditions belonging to the completion of an antecedent training of a more general character in arts. Although the status of both the education of engineers and of their calling is still such that all courses of engineering study in this country are, in their earlier portions, combinations of arts and technics, yet the distinction is vital. Training in arts is of a liberal character; its purpose is a general cultivation of the individual, and it may be accomplished by certain series of acquisitions in various portions of the broad field of arts; each set of results, characterized by the same degree of excellence, being equally effective. Hence the elective system of studies which has been so wisely developed in some of the greater universities.

The purpose of any given course of professional training, on the other hand, is perfectly specific and the necessary acquisitions are included within the limits of a rather narrow range of subjects more or less closely related and possessing considerable similarity or, at least to some extent, the same motive. In the older learned professions this sequence of a broad and general cultivation prior to and forming the foundation of the subsequent professional training is well defined, and the ultimate nature of the case in engineering is precisely the same as that in law or in medicine. By means of a liberal training the requisite powers of observation and a sound judgment are more symmetrically developed and far more accurately applied in consequence of truer conceptions of the object on which they are brought to bear, and a correspondingly enhanced power of healthy mental assimilation is acquired. The broad cultivation, it matters little when or where it is obtained, is the only effectual corrective for that narrow and malformed excellence in some special direction, which, while it is certainly much better than no excellence at all, falls lamentably short of the vigorous and well rounded product of the ideal education in engineering. I unhesitatingly place, therefore, as the first and fundamental requisite in the ideal education of young engineers, *a broad, liberal education in philosophy and arts*, precedent to the purely professional training. It would be well, although not imperative, that the liberal education should be given a trend, in its elective portions, toward the special work in engineering which is to follow. I am inclined to believe that such considerations may wisely govern that portion of the student's career, but they should govern in a subordinate way only. The main purpose should be such a cultivation of human qualities as will subsequently enable engineers to meet men as well as matter. If there is any one quality which is marked by its absence in the educational and intellectual outfit of engineers at the present time, it is that by which, in bearing and in communication, men persuade and control other men in the business of life. It is a high attribute, I grant, to "so control the great sources of power in nature as to adapt them to the use and convenience of man," but all that power of control is essentially material and utterly barren of results unless other men, or even communities, may be first persuaded that their "use and convenience" are really to be subserved. No greater error can find lodgment in the minds of engineers than the assumption that this general education is purely disciplinary in character and possesses no direct practical value. It has immediate value of the highest order. At the present time there is no executive position in the whole field of industrial activity, including the vast sphere of railway operations, which is not only open to engineers, but actually demanding precisely the services for which their training should fit them. Again, the duties of the consulting engineer are rapidly extending so as to include the exercise of the most potent influences in the control of enterprises depending not only upon his scientific knowledge as an engineer, but also on his capacity to convey to his clients correct impressions of the relative values of all the elements which affect their interests and on which their final action will be based.

The complete and satisfactory discharge of such functions cannot from their very nature be accomplished on a bare possession of technical knowledge. That is, indeed, essential, but it is just as essential, and perhaps more so, to know how to use it. The character of many of the questions which come before the engineer for consideration almost compel profound and solitary thought, and thus much of his purely professional activity removes him from all cultivating influences of a forensic or rhetorical nature through which men are most moved. There are, then, few professional men to whom the broadly cultivating influences of a liberal education are more needful than to the engineer. His early professional practice does not induce any development which can fill the voids of a faulty general education, while his later practice demands what only the liberal training can supply.

For these reasons I am very strongly inclined to believe that those engineering schools of the future which are to supply the highest grade of professional instruction will, for the most part, be found connected with our greater universities. Doubtless those of our isolated technical schools which have already attained eminent positions as centers of instruction in engineering will develop to even greater eminence, but the circumstances of the past are materially and rather rapidly changing, and the new conditions require more and more the university environment. The systems of instruction in all grades and kinds of the higher educational work attain to greater efficiency and respond far more readily to the requirements of a wider growth when that work is in close, living contact with all that nurtures it.

The perfect, professional education is not by its nature a product of isolation, but it is the composite and final result of every true educational influence to which the individual has been subjected. Every such influence is rendered intrinsically more effective, and the receptivity of the individual is largely increased in the university atmosphere. Although originally starting with a somewhat different attitude toward this part of the subject, I have for many years been convinced by an extended and active experience, considerably more than half of which has been spent in the most practical kind of practical work, that the views I have expressed cannot be successfully contested. I have been lately more firmly settled in this conviction, if possible, by the fact that in Great Britain, where education in engineering science for engineers has been quite generally regarded as of secondary importance, the University of Oxford has made complete, within the past four or five years, the list of all the principal universities of the United Kingdom affording courses of study in engineering. It is singular that there should have been any doubt or indifference in regard to the university training for an engineer in a country where one of the earliest systematic courses of civil engineering study was founded in a university and made famous by the name of Rankine.

Nevertheless, that which the professional training of the engineer by its nature requires has spontaneously assumed the form of a demand, to which the university best responds, and it is as true for this and every other country as for Great Britain. It will, of course, be rejoined that many of the greatest names of the past in engineering practice have attained their eminence in many cases without the aid even of any advanced education whatever, and that what has not aided in the attainment of such marked success cannot be imperatively necessary to any degree of success. Now it may be said at once that it is not any part of the purpose of an engineer's training to ascertain how little he may know and yet succeed; nor again, are the exceptional powers of genius, or the still more exceptional aids of favoring conditions of life, available for service in the equipment of the great majority of engineers who are to form the profession of the future.

The real answer, however, to such an observation is short and simple. There has been, strictly speaking, no profession of engineering except within the period of not more than about the last thirty-five years. The eminent men who are so frequently named as the engineers of the past were truly great constructors, but they cannot be placed in the same class as the professional engineers of the present day. Their chief characteristics were a certain kind of genius for construction, and boldness. I yield to no one in honoring their memories, but it cannot be denied that they never could be sure of their results except when they had wasted enough material in one structure to make a duplicate under modern design. Any modern engineer who should undertake to follow their precedents would soon find himself without a clientage. Those precedents make admirable monuments, but the engineer of the present must not direct his practical operations by them, but by economic conditions which are based upon exact scientific treatment of all the elements that can influence the end which he wishes to accomplish; and this brings me to what I shall name as the second fundamental characteristic of the ideal education in engineering, namely, *a thorough training in what may be termed the natural philosophy of engineering, which embraces all that body of mathematical and scientific knowledge constituting the pure theory of engineering operations.* This lies directly at the foundation of the professional engineer's practice. I do not say that it is his practice, but I do maintain that it constitutes a most important part of its foundation. Indeed, this feature of an engineer's educational training is as profoundly practical as it is profoundly theoretical; it involves the rules of practice by which an engineer is to reduce his inevitable errors to a minimum, for he cannot avoid them all except by doing nothing. Now, whatever duty an engineer may be called upon to perform in a professional way, whether to design an engine or an electric plant, or to build a bridge, a system of water works, or a railroad, he is inevitably compelled to pursue either the one or the other of two courses.

He may blindly follow precedents, and do something simply because somebody has done something else more or less like it, and so adopt the handbook method of construction (for it is not engineering), and thus fudge along to a result which may for a time satisfy his clients and enable him to secure his compensation, but which he is utterly unable to defend from criticism, and which sooner or later the better equipped engineer must usually be required to remodel or reconstruct, either in whole or in part. Or, on the other hand, he may approach his work with an intelligent appreciation of the principles or laws which govern the physical sequence of the things that he is to control and adapt to the use and convenience of that part of mankind served by his clients or directly by himself. In one case he imitates and in the other he creates. In the former he is defenseless against his own ignorance, while in the latter he is equipped for perfect safety, even though he may occasionally err. I do not underrate the value of experience in completing the education of the engineer; experience is an imperative necessity for every human being, and the engineer forms no exception to the law. In fact his complete education consists of two parts. The first is that systematic and logical training in so much of the mathematical and physical sciences as is included directly in engineering operations or as may be indirectly required by them, and which collectively constitutes the natural philosophy of engineering, which training is secured only in the professional school; while the second results from the experience of the first few years of the young engineer's practical life, and it consists in attaining a capacity to submit the acquisitions of the first to the operations of common sense and a well trained judgment, and thus make them applicable to the real conditions of professional practice. In the latter, the engineer has to treat precisely the same things as in the former, but not under the same simple conditions nor with the same accuracy of definition. The determinate characteristics of pure theory transform themselves into the most elusive indetermination. Nevertheless, qualitatively they are still the same, and it is the whole essence of modern engineering practice to so control and adapt the laws and quantitative deductions of the ideal conditions of engineering physics as to make them fit with reasonable accuracy its very varying and complicated conditions. That is the highest art of the engineer. There is nothing beyond it, and anything less is crude and unsatisfactory. It is evident from the very nature of this result that its accomplishment can only follow a thorough scientific training in the professional school. I wish, however, to make at this point a very sharp distinction between the abstract scientific training of the student in engineering and the same grade of instruction for the student in pure physics. Those two students are acquiring scientific knowledge for two very different purposes, although many portions of the two fields overlap and, indeed, are identical in many characteristics. The study of pure science requires a wide range of investigation and a thorough knowledge of the interrelation of all the departments of physics; this includes exceptional facility in the experimental and analytical treatment of all problems under ideal conditions.

The student in engineering should also be given a sound elementary grounding in the main departments of physics, but his advanced physical studies must necessarily be limited by the requirements of his future profession. The selection of subjects and the mode of treatment must be governed by the same motive. Whatever he does should be adapted to his life work, and so clearly and evidently adapted that he can see and appreciate the purpose of his efforts. His powers of investigation and analysis should be developed into a condition of vigor and facility in those directions along which he is to work. In order to accomplish these objects, without which the probability of his marked professional success is remote, his mathematical training must be of the best. I cannot insist too strongly on this point. It matters little that the engineer is seldom required in his practical life to use the pure mathematics for purposes of investigation. He needs them most urgently in his course of study as affording a foundation for his mechanics and for the subsequent analytical treatment of such subjects as the elasticity and resistance of materials, hydraulics and the general theory of machines, the theory of bridge structures, water and wind motors, thermo-dynamics and the steam engine, electro-statics and electro-dynamics, and every other branch of engineering physics. These are intensely practical applications of pure mathematics, and engineers cannot hope in the future to attain to a high grade of professional success without facility in their use. They illustrate and emphasize the meaning of my statement that the mathematical and physical portion of a course of study in engineering should be so constituted as clearly to show their relationship to subsequent professional work. There is another advantage gained by mathematical training which is less important only than that just stated, namely, mental discipline of a logical character. If mathematics are anything, they are logical, and no student can intelligently and rationally pursue the study without acquiring close logical habits of thought of the greatest value in his subsequent practice. It is precisely this mental discipline which will give value to his professional advice on the comparative merits of various proposed works to accomplish a given end. It trains him to carefully weigh all evidence for and against any proposition, and teaches him to avoid that common and frequently fatal error of assumption of conditions not known to exist. If every engineer should make as thoroughly critical and accurate an examination of all the governing circumstances of every work he undertakes as is required for the correct solution of a mathematical problem, a great many machines that have been constructed either would have been designed very differently or not at all, and at least a few completed structures would be found in other locations than those they occupy. In short, it is difficult to form any rational conception of a course of study in engineering other than that in which a thorough treatment of mathematics is the feature of fundamental strength. Without it, study in engineering is degraded to a mere descriptive superficiality of technique. An intimate relation exists between mathematical and physical science and the professional practice of engineering which is most essential to the well being of the latter. This principle has been clearly recognized in some of the oldest and strongest engineering schools of this country and Europe, but there are some quarters in which it has not been admitted.

The first of the James Forrest lectures before the Institution of Civil Engineers, of Great Britain, was recently delivered by Dr. William Anderson, and its prescribed subject was the "Interrelation of Abstract Science and Engineering." The accomplished lecturer, who is an eminent engineer, deplored the well known fact that the engineering profession of Great Britain has in the past clearly disregarded the scientific elements in the education of young men intending to become engineers. He frankly admitted that Continental and American engineers had, by pursuing the other course, gained such material advantages over those of Great Britain that the latter had lost perhaps irretrievable ground. At least he maintained that they could never even hope to recover it except by making an advanced and thorough study of abstract science a prominent and indispensable portion of the educational training of young engineers. He did not admit that there could be any alternative; on the contrary, he based his thesis squarely on the present condition of engineering practice in the United Kingdom, and contended that the results demonstrated the positive necessity of abstract scientific knowledge to the engineer. On the Continent, this has always been true of the German Polytechnics and the French professional schools of engineering, and largely so of the most advanced engineering schools in this country; yet there is not entire absence of the danger that in the fierceness of competition for large numbers of students in the greater universities of the United States, a requisite degree of scholarly excellence may be forced to give place to a condition of things more conducive to a greater number of graduates. Another most significant fact is the comparative late change in the prescribed qualifications for the grade of students in the Institution of Civil Engineers, by which a scientific education is now deemed essential, where it was heretofore scarcely or indifferently recognized. These are very important facts; they are not the opinions of theorists nor the erratic and irresponsible utterances of impracticable men, but they are the spontaneous expressions of needs born of a radically different system from that of the ideal engineering education, which I contend is not only

consistent with the present condition of engineering practice, but imperatively demanded by it. The engineer without that which such an education supplies works under serious direct and indirect curtailments of powers, and they are the more serious because by their nature they are scarcely discoverable by the sufferer.

It is one of the commonest matters of observation that the uneducated or imperfectly educated man possesses, in general, but crude powers of observation and interpretation, or none at all, of the physical things about him, and he is, consequently, constantly led into error by the very facts which ought to be his guides. The scientific training of the student in engineering, on the other hand, will give to the engineer a basis for the most acute and accurate powers for the interpretation of his experience which he can by any means acquire. It will give him a strong and healthy mental digestion with which to build up a professional individuality from the whole body of his practical experience, including the driest and most obstinate portions. Further than this, an extension of the same principle induces a receptivity of impressions from influences a little beyond the immediate physical facts of his practice and in the region of economic and general interests affected by them, so that he becomes fitted to fill a broader professional field. The higher extensions of engineering practice of the present day reach interests so thoroughly and even profoundly scientific in some of their features, and so broad and general in others, that no narrow and merely technical education will meet the requirements of the case, and it becomes rapidly less fitted to do so from year to year. The professional engineer is no longer a man with even marked aptitude for construction only. It has come within his sphere, not only to employ and to adapt the principles of engineering design, construction and operation, but also to so present and enforce his conclusions in relation to their effects on economic interests as to carry conviction to the minds of those who direct the latter; and this implies the cultivation of every power calculated to enlarge and strengthen the relations between an individual and those about him. His abstract operations touch at many points living affairs of the community, and it is one of his highest duties to so govern those operations that the interaction of all related interests may be quickened and made more efficient. The capacity of extending these general relations and placing himself in close touch with the interests to which they lead is by far the greatest power which the engineer can exert in the legitimate extension of his clientage, and it has the added advantage of being absolutely free from that abhorrent method of loud newspaper advertisement of the quack variety by which a man may truly keep his name everlastingly before the public, but which, after all, gains him but notoriety, and not reputation. In any aspect of the subject, therefore, whether in the abstract or in relation to pecuniary compensation, it must, I think, be admitted that the education in engineering which both trains a man to be a power among men and equips him with the highest quality of strictly professional preparation is the only education which meets or can meet the requirements of the best engineering practice of the present or of the future.

It is probable that the general principles I have stated are more forcibly illustrated by the progress of mechanical engineering in the field of the application of steam to industrial purposes, and in electrical engineering, than by such results as civil engineering has thus far afforded, although the observation will not hold true in regard to the latter as connected with executive and general matters. The Pennsylvania Railroad is as marked an illustration of the adaptability of engineering principles and practice to a broad engineering enterprise as can be found at the present time. It is no exaggeration to state that its management has been in the main shaped and directed under influences exerted by the highest grade of engineering education. Further than that, its operating efficiency and economy of maintenance have for many years been maintained at a remarkably high standard by the constant application of what may be called the abstract scientific principles of the natural philosophy of engineering to every detail of those branches of its management, and the wisdom of the procedure is expressed in the dividends. The earliest metallic bridge structures in this country really worthy of the name were the small cast iron or cast and wrought iron spans designed by Squire Whipple. Although the material was in many respects of indifferent character and ill adapted to his purposes, and although many details were exceedingly faulty, the fundamental designs of the structures were scientifically correct, and the efficient service which they continued for many years to render under very much heavier loads than those which they originally were intended to carry shows that they were admirable pieces of engineering work; and they were admirable in spite of the very indifferent material which the iron market then afforded, in consequence only of the sound abstract scientific principles on which their designs were based. Whipple had a perfectly clear conception of the respective functions of chord and web members, which enabled him to design them for the precise duties they were to perform, without the crude and unscientific experimentation with models which preceded the construction of the great tubular structures, and which left their designers (in their apparent ignorance of the relation between chord and web functions) in doubt as to the carrying capacity of their productions, or whether the latter would need adventitious re-enforcement, until they were actually completed and tested. From Whipple's time to the present, every material feature in the vast advance of bridge design in this country has been prompted by continually closer scientific study of the principles of that branch of engineering; and such tests of full-sized bridge members as have been made have simply and only confirmed what theory has already indicated; in no instance have they contradicted the results of abstract scientific study. They have been of inestimable value in supplementing theoretical work by the establishment of quantitative deductions, without which many theoretical conclusions would fail to possess a determinate character.

This position is not even weakened by the fact that the ideal conditions of the purely scientific treatment of these engineering questions are transformed into others in the actual case infinitely more complex. There is no possible way to so clear a realization of the complex circumstances of the actual case as by its abstract scientific study, and there is absolutely no way whatever to an intelligent adaptation of experimental results to the complexity of practical conditions except through the aid of abstract scientific study of the pure theory involved. It requires no extraordinary acquaintance with engineering literature to discover the most convincing evidence of the truth of this proposition. The perennial discovery of new long column formulæ, the erroneous interpretation of the results of the transverse tests of solid beams, the claims for a hydraulic motor of efficiency greater than unity in the comparatively near past, together with other similar theoretical monstrosities, are not too old to be ignored or forgotten. The general observation to which these instances give force is equally applicable to every field of engineering activity.

(*To be continued.*)

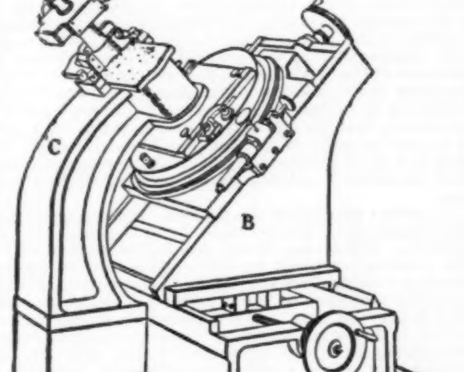
A NEW APPARATUS FOR MEASURING PHOTOGRAPHIC PLATES.*

THE new apparatus, constructed by M. Gautier, was installed in May, 1892. This apparatus is a casting. It consists of a fixed horizontal piece, A, furnished with two rails, on which slides an inclined plane at an angle of 45 deg., moved by a screw 0·18 m. in length, with a pitch of 0·005 m. On this inclined plane another screw of the same length as the first moves a cast frame, upon which is a movable circle, without graduations, carrying the fixed frame destined to receive the plates to be measured.

Each plate, when in place, is susceptible of three motions; a rotation, serving to orient in any required direction, and two rectilinear motions, one of which is effected on the horizontal piece, A, the other on the inclined plane, B.

Each of the pieces, A and B, is furnished with a scale divided to millimeters, serving to count the turns of the screw. The curved piece, C, which is cast with A, terminates in a large groove designed to receive the microscope and micrometer box.

The heads of the two micrometer screws are divided



to 100 parts. The value of one turn of each differs little from 1′; the tenths of divisions may be estimated, so that the readings may be made to about 0·06″.

* From "Rapport annuel sur l'etat de l'Observatoire de Paris, pour l'année 1892."—*Astronomy*.

THE TELE-PHOTOGRAPHIC LENS.

By W. K. BURTON, Imperial University, Tokyo, Japan.

UNDOUBTEDLY one of the greatest novelties in photographic optics is the lens to which the above name has been given. A short description of the nature of the lens and of the uses to which it may be put may, therefore, interest your readers.

It was stated, when the tele-photographic lens was first introduced to the public, that it was merely an adaptation of the telescope of Galileo, and that therefore it was no novelty. As well might it be said that no photographic objective whatever has any novelty, inasmuch as there were objectives on somewhat the same principle before photography was invented. In the most recent form of the lens as invented by Mr. T. R. Dallmeyer, there is at least as much novelty as there has been in any photographic lens ever invented, not excepting the Petzval portrait lens. It is the lens in this form that I have experimented with, and that I propose briefly to describe.

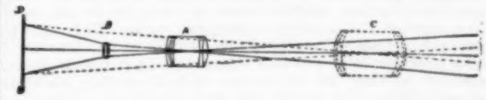
It is true that the lens is, in general principle, the same optical arrangement as the telescope of Galileo; that is to say, the telescope that we continually use under the name of the "opera-glass," which consists of a converging lens of large diameter and short focus, with a diverging lens of small diameter and short focus, the latter sometimes called the "eye-piece," which it is, in so far as it is approached close to the eye when the telescope is used, but the function of which is very different from that of the "eye-piece" as commonly understood in optics.

Any one can, with a common opera-glass, demonstrate the principle of the tele-photographic lens. If such an instrument be fitted upon the front board of a camera, with the small end toward the ground glass, in such a way that light may pass unobstructed through one of the barrels, the arrangement being such that the focus can still be adjusted, and if the camera be placed opposite a very bright object, it will be found that, by properly adjusting the focus of the opera glass, and the distance between this latter and the ground glass, a very large image—one several times larger than could be got with the same extension of camera using any common photographic lens—is thrown on the ground glass. The definition of this image will be found to be far from good even in the center, and it very rapidly falls off at a little distance therefrom. In fact, such a combination as that in an opera-glass, although illustrating the principle, is not of any use in practice for photographic purposes.

What had to be done to make a practical instrument was to retain the general principle, but to so form the combinations that spherical aberration should be eliminated, that the achromatization should be extended to the chemically active rays, and that the field should be made fairly flat.

In the first and comparatively simple form of lens invented by Mr. Dallmeyer, these objects were all accomplished, but there was a certain drawback with the instrument. If the spherical aberration were corrected for an object at a certain distance, and for a certain focal length—which means a certain number of times of amplification—it was not absolutely correct for other distances or other focal lengths.

This difficulty was got over and the practicability of the instrument was in several ways greatly improved in a most ingenious way. I presume all your readers are acquainted with the "diffusion of focus" arrangement of the Dallmeyer "patent" portrait lens. It is illustrated in the accompanying figures. In this A and B constitute the tele-photographic lens. A is



the "patent" portrait lens. The peculiarity of this lens is that the back combination consists of two elements that can be separated to a certain extent by unscrewing the posterior element. When this is screwed "home" the lens is corrected for spherical aberration, and gives an absolutely sharp image. When it is unscrewed to some extent, as shown at A in the cut, a certain amount of positive spherical aberration is introduced, and a soft image is the result.

The new tele-photographic lens consists of such a portrait lens combined with a small diverging lens, shown in the cut at B. The whole arrangement is so designed that, the "diffusion" cell being screwed "home," and a near object being focused, there is no spherical aberration, and the image is quite sharp. If, however, we focus a distant object, making the image smaller than the object—as will nearly always be the case in practice—it is found that the image is not now quite sharp. This is because there is some *negative* spherical aberration. It was, however, seen that the result of unscrewing the posterior element of the back combination of the "patent" portrait lens was to introduce some *positive* spherical aberration. All then that we have to do to get a perfectly sharp image is to introduce as much positive spherical aberration by unscrewing this posterior element as may be necessary to compensate the negative spherical aberration of the whole system. The thing is beautifully simple, and the result of it is that we have a lens that we can, within very wide limits, *adjust to any focal length that we please*; that is to say, within these very wide limits, *we can have any degree of amplification of the image that we wish.*

In the cut I have attempted to show how the image is brought about. In dotted lines, at C, is shown a large rapid rectilinear lens that would produce an image the same size as the tele-photographic lens at A B. The long straight dotted lines are intended to indicate the axes of pencils of light from a distant object, forming the image by this rapid rectilinear lens on the ground glass, *c d*. The long full lines show the axes of pencils of light from the same object passing through the tele-photographic lens. It will be seen how they are parallel with the axes of the pencils passing through the rapid rectilinear till they reach the diverging lens, when they are spread widely out, to form an image of the same size as that the rapid rectilinear forms.

The action of the negative lens may be popularly described in another way. It is so placed that the image produced by the portrait lens would focus just behind it were it not there. The effect of its presence is to prevent the rays forming the image from so focusing, to lengthen the pencils and to spread them out. In fact, it may be said that the small portion of the image that would focus just behind the dispersing lens, were this absent, is, by it, spread over a comparatively large area of the ground glass, at a comparatively great distance behind the lens.

Now as to the lens in practice: In appearance it is merely a quarter-plate portrait lens, with a tubular attachment at the back, about doubling the length of the lens, and supporting the diverging combination. This attachment goes inside the camera, so that, from the outside, nothing is to be seen but an ordinary portrait lens.

Let us suppose that we take out our camera, focusing any view with the landscape lens that we are in the habit of using—say a rapid rectilinear—and observe the size of any prominent object near the middle of the ground glass. If, now, we remove the landscape lens and, without altering the extension of the camera, fix the tele-photographic lens to the camera, we will find that, by focusing with the rack and pinion of the portrait lens—not by altering the extension of the camera—we get an image that appears enormously larger than that we got with the landscape lens. As a matter of fact it is, linearly, four to five times as large. This does not sound much, but it means a great amount of enlargement. It means the amount of enlargement that we should get by enlarging from a quarter plate up to 17 × 13 to 21¼ × 16¼. Should we want a larger image, all that we have to do is to extend the camera, and focus again, when we get an image that is larger, about in proportion to the extension of the camera. In either case, if the posterior element of the back lens has been screwed "home," it will be found, on examining the image, that it is not absolutely sharp, however we may focus. It is necessary to unscrew the posterior element, just referred to, to a certain extent, one complete revolution being sufficient to compensate for the greatest spherical aberration that occurs. This adjusting of the back element is the only troublesome part of the process. The adjustment can only be effected by trial, and to get at the cell involves, with the lens in the form in

which it is sent out, the removal of the extension tube supporting the negative or dispersing element, or the removal of the portrait lens. In the case of my own lens I have made an arrangement, that it would take too long to describe here, whereby the adjustment can be made from the outside.

One or two points in connection with the use of the lens in practice: The faintest vibration must be avoided, especially when the camera is considerably extended. In such a case, with the camera apparently quite steady, it may happen that the image may be seen visibly trembling on the ground glass. Of course, no tolerable results need be expected in such a case.

In all cases, but especially with long extensions of the camera, the depth of focus is but very slight. Consideration of the optical principles involved will show that this is inevitable. Depth of focus can be got only by the use of a small stop.

The field of the lens is somewhat round, the roundness being of the opposite kind to that met with in ordinary lenses; that is to say, the field is convex toward the lens. I have not found any practical difficulty on account of this in using the lens, and the effect of the roundness is eliminated by the use of a small stop. I hear, moreover, that Mr. Dallmeyer intends to introduce an improvement that will render the field flat. This consists in a short tube or body provided for the portrait lens, when it is to be used as a part of the tele-photographic lens. This would greatly increase the roundness of field of the lens used as a portrait lens, but this roundness is of the opposite nature to that shown by the whole system, so that approaching the lenses of the portrait combination to each other flattens the field of the tele-photographic system, as a whole.

I send you an example of the work of the lens, as compared with that of a "long focus" landscape lens. The originals are on 12×10 plates, and show the Tokyo racecourse and grand stand from Kaga Yashiki. The distance of the grand stand is about a quarter of a mile. The small scale negative was taken with a landscape lens of 22 inches focus, the other with the tele-photographic lens, the extension of the camera being the same in both cases.

I may mention that I have fully satisfied myself, by actual trial, that the image got by the use of the tele-photographic lens is superior in definition to that got by enlarging a small negative made by the best of ordinary photographic lenses. An architect has indicated to me a possible use of the lens to those of his own profession. He points out that it is possible to get, by its use, photographs that are practically in *isometric projection*, and that this may frequently be of use to architects. This argument, however, cuts both ways, for photographs in isometric projection are photographs devoid of linear perspective.

I consider that we have, in this tele-photographic lens, not only an instrument interesting from a scientific point of view only—as some seem to consider it, and, as I must confess, I was somewhat inclined to consider it myself at first—but one that will be of real use in practice.—*American Journal of Photography.*

NEW FIRE DAMP INDICATORS.

THE presence of fire damp in the network of galleries of a coal mine may be rapidly determined by an analysis of the currents of air that rise to the surface, and that are called return currents. Normally, they ought to contain no more than 0·5 per cent. of coal damp, and if they show an increase of but 0·5 per cent. in the proportion, it is certain that an abnormal disengagement is taking place at some working point. A detailed examination of the places then becomes urgent. Moreover, experiments, many times repeated, have proved that air containing feeble quantities of fire damp, even less than one per cent., may become explosive when it is charged with coal dust. With the ordinary oil safety lamps the presence of less than three per cent. of fire damp escapes observation. So, for years, the problem has been to combine an apparatus that should permit of estimating the feeblest proportions of fire damp accurately—a problem that is so much the more difficult in that the apparatus, in order to render real service, must give sure indications, not for a few minutes, but at least during the entire duration of a tour of inspection, say about three hours. We know that the blue aureola that forms at the apex of a flame placed in a mixture of air and a combustible gas permits of recognizing the presence of fire damp. In order to improve the conditions of observation, Messrs. Mallard and Le Chatelier have studied the flames of alcohol and hydrogen, in which the most voluminous and apparent aureolæ reveal the presence of feeble proportions of combustible gas. The French commission on fire damp being impressed with the question, verified the fact, but judged the use of alcohol dangerous and that of hydrogen difficult in practice. This occurred in 1882. An alcohol lamp was constructed some time afterward by a Mr. Pielor, an Austrian engineer, but, as the use of it was deemed dangerous, it did not become popular. Things were remaining in this state when there were simultaneously presented to the scientific world two portable lamps, one with an alcohol flame and the other with a hydrogen flame, for which were claimed the qualities of safety, precision and practical use.

The lamp with hydrogen flame was submitted to the Royal Society of London by Dr. Frank Clowes, professor of chemistry at the University of Nottingham. The hydrogen, stored up under pressure in an auxiliary receptacle, enters the lamp through a tube that debouches alongside of the wick and becomes lighted in contact with the latter. If the wick is lowered, there no longer remains anything but the hydrogen flame for the test of the fire damp, and if it is afterward raised, the lamp is relighted and serves for illumination.

The possibility of these different operations may well be conceived; but, for a mine lamp, they are still too complicated to justify the practical character that the inventor attributes to it; in fact, the hydrogen, compressed in a special reservoir to a pressure of from 100 to 120 atmospheres, is charged in small cylinders, weighing 400 grammes, that are capable of supplying the lamps for 40 minutes. These cylinders, as shown in Fig. 1, No. 1, are mounted upon the base of the lamp by an ajutage that enters the tubulure corresponding to the internal tube. Upon loosening a screw, the hydrogen is permitted to pass into the lamp, when it is desired to proceed to a test. The supply of hydrogen is therefore limited, and, in case of a service prolonged beyond forty minutes, it is necessary to renew it by replacing the cylinder, and this is always troublesome, seeing the delicacy of the connecting and closing parts. Besides, admitting, even, that the substitution of the oil flame for the hydrogen flame is effected without extinction, how is it to be recognized that it is necessary to pass from one to the other? We have seen that the ordinary safety lamp gives indications only in the presence of 3 per cent. of fire damp, and that the existence of less than a hundredth may yet be, in certain cases, considered as dangerous. It will be necessary, then, either to lose valuable time in manipulations or to be exposed to ignoring the existence of any fire damp less than 3 per cent. Finally, if it is desired to make any observation of some duration, the variation in pressure of the hydrogen in the receptacle constantly modifies the regulation of the flame and renders the estimates uncertain. The inventor himself admits, moreover, that his apparatus would prove too heavy if he had to make of it a lamp of long duration, and that it is to be utilized only in return current galleries. It is therefore a laboratory lamp rather than a mine one.

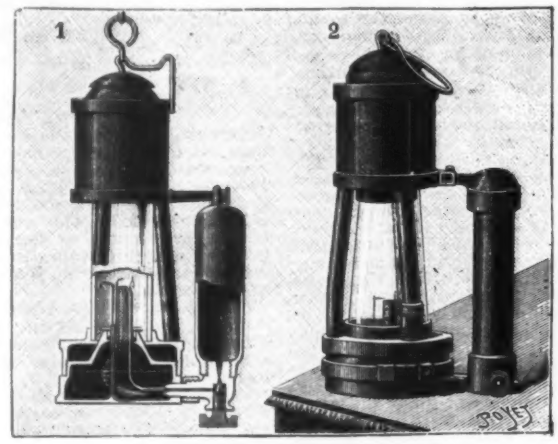


FIG. 1.—CLOWE'S LAMP WITH HYDROGEN FLAME.

1. Mine model. 2. Laboratory model.

A perfect solution of the problem would require that the illuminating flame should be at the same time an indicator of fire damp in the feeblest proportions; but the aureolæ produced by the combustion of the fire damp are themselves too pale, and consequently indiscernible, alongside of an illuminating flame, in order that it may be thus. It was therefore more practical to try to devise a grisometric lamp properly so called, presenting all the conditions of safety desirable and giving very accurate indications, from 0·1 per cent. of fire damp up to proportions of from 3 to 4 per cent., in which oil lamps furnish data sufficient in practice.

These results are obtained with the lamp elaborated by Mr. G. Chesneau, engineer of mines, and based upon the use of a flame of methylic alcohol, to which is added chloride of copper, designed to brighten the tints of the aureolæ that form in mixtures of air and combustible gas.

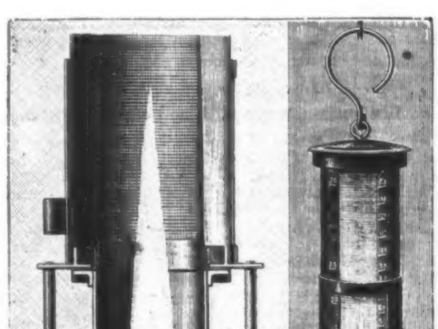


FIG. 2.—CHESNEAU'S MINE LAMP WITH ALCOHOL FLAME.

This fire damp indicator or gasometric lamp consists of an alcohol reservoir, a crown of double wire gauze surmounted by sheet iron cylinder, and a cylinder of wire gauze. The latter is covered with a sheet iron jacket provided with a window of observation, closed by a sheet of mica. An annular diaphragm in the interior of the jacket completely closes the bottom of the latter in resting upon the collar of the wire gauze cylinder through the interposition of a washer of asbestos paper, in order to diminish the heating of the jacket. The top of the latter is provided with apertures protected by a fixed screen that prevents currents of air from reaching the wire gauze cylinder with velocity. A second movable screen, formed of a cylinder of Dutch metal, and placed in front of the bottom of the mica window, prevents the deposit of mist, that tends to form internally upon the mica in currents of fresh air. Finally, a third and fixed screen protects the crown against currents of air. It is provided with orifices that may be closed, if need be, by means of a movable ring; but such closing must be done only in very brisk currents of air.

The regulating of the lamp is done in pure air. In order to effect it, the upper edge of the collar of the wire gauze cylinder is brought exactly to the level of the eye, and the set screw is so maneuvered that the four zones of the conical point of the flame (yellow, bright green, greenish, and very pale gray light) are no longer perceived, except at the point of the greenish light.

If the lamp thus regulated is placed in an atmosphere of fire damp, we find already there the proportion of one thousandth, and, very clearly, starting from the proportion of five thousandths, that the aureola consists of a conical blue, slightly greenish part, the point of which is surmounted by a grayish and much paler light that forms a sort of hood superposed upon the greenish-blue flame, and whose intensity diminishes rapidly toward the summit. The height of the greenish cone determines the proportion in fire damp. Its tint is sufficiently bright to allow the observation to be made in a gallery lighted by ordinary lamps, which, on the contrary, mask the grayish light. Our figure represents the cone corresponding to 2 per cent. Up to 1·5 per cent. of fire damp the cone has sensibly the half of the total height of the appreciable light. Starting from 2 per cent., the flame proper to alcohol (of a yellow color, fringed with green) begins to rise above the collar of the wire gauze cylinder. In measure as the proportion increases, the greenish blue flame and the grayish flame proper to alcohol increase simultaneously in height. At 3 per cent. the greenish blue flame reaches the height of the wire gauze cylinder. Beyond we no longer perceive anything except the flame proper to alcohol, which continues to elongate up to 5·75 per cent. of fire damp, but in having confused colors. Beyond, the flame disappears from the wire gauze cylinder, and the mixture of air and fire damp, having become inflammable, burns no longer except in the cylinder crown; then all is extinguished in a few seconds.

An observer, having gained experience by several visits to drifts infested with fire damp, may thus be enabled to estimate the latter to within about a thousandth, between the limits of 0 and 3 per cent. The lamp lends itself to very precise determinations for three hours, starting from the lighting, and is capable of still serving for about an hour as an indicator of the presence of fire damp.

Let us now examine whether this grisometric lamp combines within itself the three indispensable conditions above enumerated to allow it to be put into the hands of miners.

Safety.—The trials made at Anzin, Lens, Lievin, St. Etienne, Renchamp, etc., are concordant from the standpoint of safety, and show that the lamp behaves in fire damp mixtures like a safety lamp of good construction. It may be carried without danger to all points of a mine, the entrance of air always taking place at the bottom of the lamp, and a sudden explosion at the top of the wire gauze cylinder not being able to occur, as in lamps that are supplied with air through the top. The wire gauze cylinder never becomes red hot, and an extinction always takes place in explosive mixtures. Such conditions, essential for safety, are due to the method of circulation of the air in the lamp.

Precision.—More than 200 comparisons between the proportions shown in subterranean works by the Chesneau lamp and the analyses of corresponding entrances of air have been made by means of the apparatus of Mr. Coquillon and Mr. Le Chatelier.

The errors found are thus distributed:

Error nil	36	per cent.
" of 0·1 per cent. of fire damp	45·6	"
" 0·2 " "	12·5	"
" 0·3 " "	4·5	"
" 0·4 " "	0·5	"
" 0·5 " "	1	"
" above 0·5 " "	1	"

The error of the lamp has therefore not exceeded a thousandth of fire damp for more than four-fifths of the comparisons made. This great precision, due to the coloration of the aureolæ by he salt of copper, shows that the alcohol is capable of giving flames that are always identical. The only condition that it

must fulfill, according to Mr. Chesneau, is to have always the same specific weight.

Practical Character.—It follows from this fact that the lamp is capable of operating interruptedly during the entire duration of a prolonged tour of inspection, that is to say, for four hours, and that it may be employed, as experiments have proved, in drifts as well as in galleries of return of air.

Thanks to Mr. Chesneau's persevering researches, we now possess an apparatus that permits not only of regulating the conditions of aeration of mines infested with fire damp, but also of following the disengagement of explosive gas and its distribution in the subterranean atmosphere.—*La Nature.*

THE DEPARTURE OF DR. NANSEN'S ARCTIC EXPEDITION.

Dr. Fridtjof Nansen's Arctic expedition sailed from Christiania, in the Fram, shortly after noon, June 24, 1893. The day was characterized by a cloudy sky, with cold wind and drizzling rain—a sudden but very welcome contrast to the tropical heat and drought which have existed here for many weeks past. At an early hour several members of Dr. Nansen's crew, all looking remarkably fresh and cheerful, rowed off to their ship, the Fram, which lay at anchor in a little bay of the fjord, alongside an old bark-rigged training ship, within two hundred feet of the shore. Between seven and eight o'clock the bay became crowded with ferry steamers conveying passengers to business. Each steamer in succession, in drawing near to the Fram, slowed down; hats and umbrellas were waved, and volleys of hearty cheers greeted the Fram's crew, who were all steadily at work in different parts of the ship coiling ropes and clearing the running gear.

Toward eleven o'clock, the published hour of departure, all was in readiness, but Dr. Nansen had not yet arrived. The Fram was now surrounded by a host of small boats of every description—Kyak canoes, and shoe-shaped craft, miniature gondolas, racing skiffs, naval gigs, yachts' dingies, and steam launches, all more or less decorated with bunting and with branches of silver birch. Upon the quay, and by the shore, several thousand spectators had gathered to witness the sailing of the expedition. It was evident, by their earnest attention, that no sluggish indifference clouded their imagination. As they gazed intently at the bluff, broad-beamed Fram, it appeared as though a thousand varied pictures of the vessel's aspect in the barren ice field a few months hence, and of the twelve venturesome Northmen, toiling and enduring, passed before their eyes. The obvious dangers and privations about to be experienced by these men, for an unknown period, in order to test practically what is, after all, a mere personal theory of Dr. Nansen's, produced a deep impression upon the spectators, who were filled with a combined sentiment of awe and admiration. As the time passed, and the city clocks struck the hour of noon, and there was still no sign of Dr. Nansen, the murmuring crowd of spectators became silent. It was clearly evident that their hearts were in sympathy with the actors of an invisible scene, wherein the bitter pangs of parting with wife and babe formed the pathetic theme.

Suddenly all eyes were directed toward a tiny petroleum launch, which came speeding toward the Fram. There were two occupants. In the bow stood a sailor, boathook in hand; in the stern sat Dr. Nansen. A few moments later, when the launch dashed alongside the Fram, and Dr. Nansen, looking haggard and half dazed, climbed upon his vessel, there was a dead silence among the spectators; no voice was raised to greet or cheer him. A more impressive tribute than this sympathetic silence could not have been rendered. Even a momentary contemplation of Dr. Nansen's probable feelings at the moment of his embarkation must have impressed the coldest observer. The heart-rending farewell, with his wife's tearful voice still echoing in his ears; the almost overwhelming responsibility of the whole expedition, of the eleven men who place their lives entirely in his charge, of his own reputation, which is, doubtless, far dearer to him than life—all these serious and harrowing thoughts must have been present in Dr. Nansen's mind at that moment, and he stood the test with characteristic calmness.

A few minutes after Dr. Nansen's arrival on board, the anchor was weighed, and the Fram actually started upon her voyage, followed by several yachts and steam launches bearing numbers of Dr. Nansen's friends, who were anxious to accompany the expedition upon the first few miles of the journey. As the Fram steamed slowly down the fjord, three gun salutes were fired from the various batteries, all of which were promptly acknowledged by the defiant barking of Dr. Nansen's favorite sledge dog. Half an hour's slow steaming down the fjord brought the Fram abreast of Dr Nansen's home at Lysaker; and here for the first time the sun beamed through a rift in the dark rain clouds, and shone radiantly upon the distant shore, revealing the figure of Mrs. Nansen, clad in white, standing upon the rocks by the water side. The view, which lasted but a moment, soon faded in the rain mist, and Dr. Nansen gazed in vain. Bands of musicians, who figured prominently in the bows of the attendant steam launches, played in somewhat mournful strains the national airs, "Sons of Norway" and "Yes, We Love this Country;" while every few minutes a chorus of voices would shout: "Long live our Nansen!" "Welcome home, Nansen!"

Almost immediately after passing Lysaker the rain commenced to fall in torrents, and, in fact, it continued to pour during the remainder of the day. When about five and twenty miles from Christiania most of the steam launches took leave of the Fram, amid a storm of hearty cheers and shrill steam whistles. Before finally parting I took a last look around the Fram. On deck everything was shipshape; below, in the saloon, my attention was first attracted to a very powerful drawing of Mrs. Nansen and her infant daughter by the famous Norwegian artist Werenskiold. The likeness was singularly lifelike. Beside this picture, sharing the only other available wall space of the saloon, hangs a typical Norwegian landscape by the same artist. The cabins of the Fram's crew all lead out of this saloon, and it may interest many people to know that the smallest, the darkest and the least comfortable cabin is that occupied by the leader of the expedition. I observed no traces of looking glasses or other toilet articles, with the exception of baths and basins. Canvas-bottomed bunks, with woolen rugs and pillows, settees, sea chests and a monster stove constituted the principal elements of furniture. As a relief to the prevailing barrenness, the walls of each cabin were adorned with gold-framed portraits of wives or sweethearts, and oil paintings of pine woods and waterfalls. On all sides and at every point I was reminded of the absolute simplicity and singleness of purpose which inspired not only Dr. Nansen, but every member of his crew. On the cabin table lay a little heap of telegrams and cable messages from various parts of the world wishing "God speed" to all the Fram's crew. Among the most acceptable to Dr. Nansen was a message from Siberia to the effect that Dr. Nansen need entertain no anxiety or doubt with regard to traversing the Kara Sea, the ice in that region being just now in a most favorable condition. Among the many messages was one from Nordenskiold, who expressed the warmest sentiments of friendship and faith in Dr. Nansen's scheme.

At the gangway, when the last launch steamed alongside, there was much affectionate leave-taking, many eyes were dim with tears and there was a reluctance to depart. Dr. Nansen shook hands with every one, he bowed and smiled in acknowledgment of all the effusive farewells, and his simple reply to all was "Good by."

Within the next few minutes the Fram vanished in the haze.—*Herbert Ward, in Illustrated London News.*

Currents after Dr. Nansen. Scoresby Sound from the map accompanying Lieut. Ryder's paper. Independence Bay from a sketch map published in the New York *Sun*, October 25, 1892. Route marked by Dr. Nansen. Published by the Royal Geographical Society.

THE GEOLOGICAL WORK OF HIGH PRESSURE GAS.

A series of experimental researches which promise to lead to important results, and which have already been applied by their author to the explanation of some difficult geological problems, have during the last few years been carried on by M. Daubrée. These experiments are concerned with the action of rapidly moving and high-pressure gas on rock masses, and lead to the conclusion that such high-pressure gas is a geological agent of no small importance. To carry out such experiments is no easy matter, but M. Daubrée has been fortunate enough to obtain the use of the apparatus used in the testing of explosives in the *Laboratoire Centrale des Poudres et Saltpêtres.* The high-pressure gas has been obtained by the explosion of gun-cotton and dynamite, the explosions being made in a steel cylinder with very thick walls, and closed at both ends with steel plugs. One of these plugs is fitted with a platinum wire, by the heating of which the charge can be exploded. The other, which under ordinary circumstances contains the manometer for measuring the force of an explosion, is modified so as to contain a block of the rock to be experimented on. A circular hole, moreover, is made at one end, so that the gas, after traversing the rock, is allowed to escape. The rock, cut in the form of a cylinder, is supported between a steel stopper and the head of a piston. The charge of gun-cotton or dynamite usually filled a tenth part of the interior, and the pressures obtained were from 1,100 to 1,700 atmospheres. In one experiment the pressure was increased to 2,300, and in another the still greater pressure of 2,400 atmospheres was obtained. Many different kinds of rock were used, such as limestone, gypsum, slate and granite, and each cylindrical block experimented on was cut through by a diametrical plane. In some of the experiments an additional very fine perforation was made along this plane.

As a result of the sudden shock of the explosions, most of the rocks were fractured. In the case of the slate this resulted in faulting. The limestone and granite were broken up and crushed, but under the influence of the pressure the small fragments were quickly consolidated so as to resemble the original rock. This property of reconsolidating under pressure, thus shown to be possessed by rocks, seems analogous to the plasticity of ice observed by Tyndall.

All the rocks experimented upon, even the most tenacious, have undergone more or less erosion. The gases have disintegrated and pulverized them, and carried out the fragments. When their action was concentrated along certain lines, true perforations—that is to say, rounded channels more or less regular—were eroded through the blocks. In the case of a granite block, the original perforation of 1·2 mm. was increased to a channel of 11 mm. The walls of these perforations after the explosions were found to be striated and polished. Sometimes the striations are parallel, like those produced by ice. At other times they spread in fan-form, and sometimes they are slightly curved.

The products of erosion are thrown out into the atmosphere, and an examination of the powder thus produced shows that a portion of the same possesses an interesting resemblance to the dust usually held to be of cosmic origin.

M. Daubrée applies the results of his experiments to explain the remarkable "diamond pipes" of South Africa. These diamond deposits are described by M. Mouelle in the *Annales des Mines* (tome vii., p. 193, 1885) as filling in cylindrical cavities of unknown depths in the rocks. These cavities appear to be cut out of the subjacent sedimentary or eruptive rocks; their upper parts are filled with a soft, yellow, decomposed rock matter, while below they contain hard volcanic conglomerate. They vary in size from a diameter of 20 to one of 450 m., and are originally surmounted by slight eminences, known as *kopyes* (little heads).

An interesting point about the general arrangement of the "pipes" is their occurrence along a straight line of 200 kilometers in length. Their walls, again, are smoothed and finely striated. These striations are often parallel and indicate a powerful thrust from below upward. No alteration is observable in the beds of shale forming the walls, except a slight elevation of their edges.

Thus in their general form, as long, narrow, cylindrical perforations in the earth's crust, they resemble the artificially produced perforations in the rocks experimented on. Their arrangement along a straight line suggests that they may have been opened along a line of fracture as were the perforations in the experiments. In the latter, the line of the eroded channel was determined by a very narrow perforation, and M. Daubrée suggests that in the former the positions of the "pipes" may have been determined in some cases by cross-fractures. The polishing and striation of the walls of the diamond pipes, again, is reproduced in the polishing and striation of the perforations in the experiments.

Another application of his experimental results made by M. Daubrée is to explain the opening out of the channels by which volcanic products reach the surface. Here, again, the linear arrangement of volcanoes, which has been so frequently pointed out, is noted as connecting volcanic vents with the experimental results. These are supposed to lie along lines of fracture, and each volcano is supposed to have been determined by a cross fracture, or some other cause, facilitating the passage of gas at that particular point. That there are reservoirs of gaseous pressure of great power below the surface is evident from volcanic phenomena generally, and given a line of fracture, with cross fractures, or other predisposing causes, the experiments prove that high pressure gas is capable of opening out cylindrical passages by which molten rock matter and fragments may reach the surface. In this connection M. Daubrée points out the occurrence of volcanic craters, of which the cones are formed entirely of rock fragments, and known as "craters of explo-

sion." Thus, near Confolens, in Velay, there is a crater excavated in the granite, and of which the cone is formed entirely of granitic fragments.

M. Daubrée further applies his experiments to explain —1, the fracturing and crushing of rocks; 2, the transport of their debris; and 3, their apparent plasticity.

Some further results show that the high pressures of some of the earlier experiments are not essential, but that complete perforations can be obtained with pressures of 1,100 atmospheres. A cylinder of granite, cut in two by a diametrical plane, and bound together with a ligature of copper, was thus excavated along its whole length by an irregular channel which opened on the surface by two branches. In the case of a cylinder of rock of which the height greatly exceeded the diameter, the perforation tended to the form of two cones united by their summits. The action of the gases is not confined to the drilling of the perforations; they have likewise grooved and striated the surfaces of the divisional planes of the cylinders. These striations and groovings are not produced, as might be supposed, and as M. Daubrée himself at first believed, by solid particles of rock carried by the gas, and used as graving tools. It appears, in fact, that the gases themselves are able to striate and groove the rock on their first contact with it.

As an interesting corollary to his experiments, M. Daubrée points out that leakage from steam pipes may in a similar way cut through metal plates. An example is quoted in which metal exposed to the escaping vapor from a steam pipe (pressure, seven atmospheres) was channeled and striated: the resulting marks were similar to those of a saw or file. A valve on a steam pipe, again, has been attacked in a similar way.

All these groovings in the metal have received a similar polish to that given by emery.

In the experiments the gases have in general caused the fusion of the surfaces which they have attacked. Thus, on the surfaces of the divisional plane of a granite cylinder the feldspar is melted into white globules forming small projections. The plates of mica have also been softened. Even the quartz has not escaped, but appears pitted in a manner which recalls the erosion produced by hydrofluoric acid.

Scales of the rock are detached by the very unequal expansion as by a sort of shock.

A black crust exactly similar to the crust of meteorites has been produced with certain stones.

The transport of the debris produced in the perforation of the cylinders of rock is applied by M. Daubrée to the history of certain cosmic dusts, and the sediments existing in some of the deeper parts of the ocean. In making the perforations the gases carry out a quantity of debris. A part of this was collected on sheets of cardboard covered with vaseline. The particles arranged themselves in concentric circles on the sheet according to their size. Some of the large particles pierce the cardboard, and even its supporting plate; the very fine particles are carried to a distance by the gases, which they render opaque. In the powder retained on the cardboard two sorts of grains can be distinguished under the microscope. The first are indistinguishable from those produced by simple mechanical pulverization; the second have a special character intimately connected with the particular conditions of the experiment.

Thus, in the case of granite, fragments of all three constituents, quartz, feldspar and mica, are found in the powder produced. But besides this, minute perfect or nearly perfect spheres are found. These are opaque and black, or slightly translucent and brownish, with a glistening surface, and sometimes furnished with a very characteristic neck. They are doubtless the products of fusion.

This latter part of the powder of erosion seems identical with certain parts of the atmospheric dust and that found in the deeper ocean, as well as in geological formations of various ages, and which have generally been looked upon as of extra-terrestrial origin. Thus the conclusion is arrived at that, while part of the so-called cosmic dust is undoubtedly of extra-terrestrial origin, the opening of volcanic and other channels in the earth's crust by high-pressure gas has also played an important part in its production.

Eruptive breccias may also have been produced by the force of high-pressure gas, as shown by the fracturing, breaking up and reconsolidating of the rocks experimented upon.

A more remarkable fact is the passing back of the pounded and broken-up rock to its original solid state under the influence of the same gaseous pressure. Thus the fragments of the rock in the experiments were found to have moulded themselves so exactly on the containing steel apparatus as to have acquired a specular polish. The rock had, moreover, taken the impress of striations upon the steel. Limestone thus regenerated showed a schistosity concentric with the cylinder. It seems obvious, then, that the rocks of the earth's crust, having so frequently been subjected to enormous pressure and so often folded and contorted, must in a similar way have been broken up and regenerated.

Another experiment showing the apparent plasticity of rocks is as follows:

A cylinder of Carrara marble without a preliminary fissure, but with furrows on one of the ends and on the side, was placed in the apparatus and subjected to a pressure of 2,400 atmospheres. It was afterward found to be perforated with a channel, and, moreover, to be accurately moulded on the containing apparatus so as to take the impress of the concentric striations as in former experiments. The furrows were completely effaced, while the diameter of the cylinder was increased and its height diminished.

The ejection of rocky matter through the channels perforated by high-pressure gas occupies another paper. In such high-pressure gas M. Daubrée contends we have an agent capable of accounting for the facts in conformity with his experimental results. Special reference is made to certain trachytic domes—as, for example, those of the high plateau of Quito—of which the form seems to indicate that the rock matter forming them was ejected in an almost solid state. These domes, M. Daubrée supposes, crown the summits of orifices (diatremes) opened by the passage of high-pressure gas, and were themselves afterward forced out by the same pressure. Attention is called to the remarkable uniformity in height observable in groups of volcanoes. This is explained as the result of origin from one common reservoir of pressure. The height of the volcanic cone gives a measure of this pressure. On the other hand, the hypothesis likewise explains the difference in height in different regions. Thus, in certain cases, reduction of pressure would be effected by lateral escape of gas, as happened in certain experiments in spite of the utmost care. A similar reduction of pressure may have occurred through the blocking of the channels of egress of the gas. This, too, occurred in certain of the experiments, notably when gypsum was the rock experimented on. With this rock the channel opened by the gas was quickly closed again by the rapidity with which the triturated rock resolidified. The paper concludes with a suggested application of the hypothesis to the cones and craters of the moon.

In another paper M. Daubrée returns to the subject of the flow of rocks under high pressure. With respect to this point he remarks that, in certain previous experiments, the rock not only moulded itself to the apparatus, but also formed thimble-shaped protuberances outside it. Further experiments were conducted with round plates placed one upon another, instead of the former cylinders. Lead plates were first experimented on, and then these along with plates of rock. One of the most interesting results obtained was the production of little "eruptive cones" of lead or rock outside the apparatus. In one case the protuberance reached the height of 36 mm. After the experiments, some of the plates were found outside the apparatus in the form of circular capsules, so closely fitted into one another as to appear soldered. Some of the lead plates remaining in the apparatus were cut through in their central parts as with a punch. The thickness of these perforated plates was found to be diminished on their borders and increased in their central portions. This effect may be compared to what occurs in many cases with contorted rocks. At the same time spaces were here and there formed between the plates thus united. Daubrée draws attention to the analogy between these spaces and those occurring between separate strata among contorted rocks, and which are often filled with metallic substances. Lamination was also produced in the plates of rock.

As a general designation for the accumulations of rocky matter crowning the summits of all perforations in the earth's crust opened by gaseous pressure, whether trachytic domes, lava flows, scoriæ cones, or the kopyes of South Africa, M. Daubrée proposes the term "ecphysema" (French, "*ecphysème*," Gr., ἐκφύσημα).

To sum up M. Daubrée's results:

(1) High-pressure gases from below are able to open out channels in the earth's crust by means of which the same pressure can bring to the surface various products.

(2) In forming such channels the gases may striate and polish the walls of the perforations in a manner recalling that of glacial action.

(3) The products of such erosions are partly of the nature of fine dust, which may be carried to immense distances, and a part of which resembles exactly the so-called cosmic dust.

(4) That the same high-pressure gas can fracture, break up and pound a rock, and afterward resolidify the same. That in thus resolidifying, the broken-up rock may mould itself accurately on the bounding walls of its inclosure, so as to take their polish and the impress of the striations upon them. And further, that portions may be thrust outside the apparatus in the form of protuberances of the nature of "eruptive cones." And thus it may be conceived that, by the force of high-pressure gas from below, rocks may be broken up and reconsolidated *in situ* to form breccias of diverse natures.

Some further applications of the experiments may be suggested.

Thus they may perhaps explain the origin of those remarkable natural pits of Hainaut, which have given rise to much discussion. In their general structure these pits are analogous to the diamond pipes of South Africa. Like them, they are more or less circular perforations in the rocks of unknown depth and filled with rock debris. Since none of the explanations hitherto applied to them seem satisfactory, perforation by high pressure gas may be tried.

Again, in certain of the experiments, the faces of the fissures in the cylinders of rock were found to be polished and striated. The polishing and striation of rock surfaces in connection with faults is known as slickensides, and ascribed to the movement of one surface over the other. M. Daubrée's results indicate the possibility that certain slickensided surfaces may rather be due to the energetic action of high pressure gas. In any case it is perhaps a little difficult to understand how a *single* movement of one rock surface over another—if we suppose a fault produced by a continued movement in one direction—could produce anything like a perfect polish. And it cannot be denied that the above experimental result shows the possibility of another cause.

And further, if we accept M. Daubrée's interpretation of his results, we arrive at the remarkable conclusion that gaseous bodies, given sufficiently high pressure and rapid motion, can polish and striate in a way generally supposed to be confined to solid bodies. This, indeed, is in conformity with the general results of advanced physical research, which tends to show that, under sufficient pressure, hard and solid bodies can be made to act as liquids, while soft and even gaseous bodies, if endowed with sufficient force and speed, act like solids.

If, then, a gaseous body, under certain conditions of speed and pressure, can polish and striate a rock without the intervention of solid particles, is it not possible that ice, given certain conditions of speed and pressure, may likewise striate and polish without the graving tools usually considered necessary? The conception of an ice sheet, or glacier, moving over the rock surface of the country with a series of pebbles and bowlders firmly frozen into its lower surface is difficult to reconcile with the physics of ice masses in motion. Hence it seems worth while to make a trial application of the experimental results in this direction likewise. Even if we do not accept M. Daubrée's view that the striation of the rock surface was accomplished by the gas alone, and hold that the intervention of solid particles was required, there is still a possible application to glacial action. For if solid particles simply carried along by a rapidly moving gas can produce parallel striations, may not particles simply carried along by the ice do likewise without being held firmly frozen into its mass? On either view, in fact, a difficulty in the conception of how a glacier striates and polishes is removed.

INSECTS INJURIOUS TO DRUGS.

By Prof. L. E. Sayre.

A knowledge of entomology to the average pharmacist has always been considered of little more value than an ornamental accomplishment, having little more application than the scientific classification and naming of the few drugs derived from the insect world. To give these proper entomological names and understand in some degree their relations to other insects and the relations of the groups to which they belong to other groups has been all that was deemed necessary for the pharmacist to know of this department of scientific study.

It needs little argument to prove that a more intimate study of insects is not only useful but is almost essential to those who are supposed to discover the cause of deterioration and to be able to combat the same intelligently. This knowledge should extend to the insect forms which infest and feed upon drugs and their preparations, as the mites and dermestid beetles and forms which prey upon the drug-eating species. This, it may be said, embraces a very limited range in the eyes of the entomologist, but an acquaintanceship with this much of the science should be, for very practical purposes, well understood.

It is not my purpose in the subjoined article to treat of the science, *per se*, or to go into any lengthy detail as to the study of drug-eating insects as has been carried on in the entomological department of the University of Kansas. An article by Prof. V. L. Kellogg and myself, describing the work of last year, will be found in the Proceedings of the Kansas Pharmaceutical Association for 1892. Since this time, Prof. Kellogg and Mr. S. J. Hunter have continued this study, to whom I am indebted for the material contributed upon the subject at the last meeting of this association. I shall in this article briefly glance at the various insects themselves found in various drugs and make some comments upon them for the better understanding of them.

Referring now to Plate I., I will call attention to

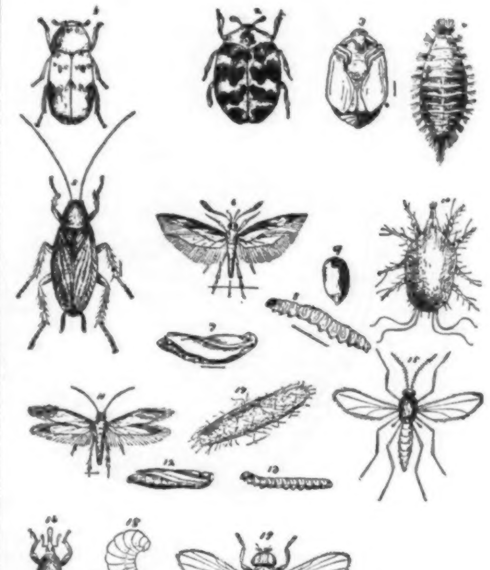


PLATE I.

Fig. 10. The natural size of this *mite* is found in Fig. 10*a*. This is the common cheese or flour mite, familiar to most of us, found in farinaceous drugs. The order to which it belongs—the mites—are characterized by having most of the mouth parts united to form a piercing beak. They have two sharp needle-like projections which correspond to the jaws or mandibles of other insects. These stylets or lancets are very useful when the mite needs to pierce some protecting envelope to get at succulent inner matter, or when the mite has to live on "dry food." This mite species lives on raw sugars, in which it appears as small white specks. At least a half dozen species of mites attack cantharids, which, we know, are insects belonging to the great beetle order.

Besides the mites, several species of small animal-eating beetles do great havoc in the jars of cantharids. The beetles of the dermestid family, to which belongs the well-known buffalo bug, or moth of the household, feed almost exclusively on the dried remains of animals; at least this is their food when in the young or grub state. Right here it may be well to interpose a few remarks upon certain peculiarities in the life history of insects, the knowledge of which is essential to the intelligent comprehension of the subject in hand.

While in certain groups of insects the young when hatched from the egg (and insects are hatched from eggs, almost without exception) resemble the parents, the adults, yet, in other groups or orders, as the beetles, the two-winged flies, the butterflies and moths, and the ants, bees, and wasps, the young appear in wholly different form from that which they will assume when full grown. For example, in the beetles, you remember, we had come to the consideration of certain cantharid-eating beetles. The first stage after leaving the egg is that of a grub or worm, so called. This worm-like

stage is called the *larval* stage, and the insect itself a *larva*.

In the case of the dermestid beetles, of which several kinds infest the cantharids, the larva is a peculiarly hairy grub, well shown in the accompanying plate. The dermestid beetle here illustrated in its various stages of growth is the buffalo bug, and in Fig. 4 is the "fish"-shaped larva with its hairy body, next the mummy-like pupa, Fig. 3, with its legs and feelers closely folded against its body. This is the second stage in the life of the beetle. After the larva has become full grown it seeks a sheltered spot, ceases feeding and becomes transformed into an almost immovable mummy-like object, called the pupa. It remains thus quiet and without eating for a few weeks (in most cases), and then emerges, the perfect beetle, Fig. 2.

There are other species of beetle which attack the pharmacist's stores; for example, *Ptinus brunneus* (we are sorry to be compelled to use these scientific names, but very few insects have common names), a small brown, slender-legged beetle, which feigns death when disturbed, does great havoc in the larval stage, in jars of allspice, capsicum, and cinnamon. *Anobium paniceum*, one of the so-called "death ticks" and much like the Ptinus, attacks agaric and several other drugs. *Lasioderma serricorne*, closely related to the *Anobium* and *Ptinus* (all belonging to the family Ptinidæ), eats, as larva, capsicum and dried tobacco. *Bostrichus dactilliperda*, another member of the same family, attacks sweet almonds. Two species of *Ceutorhynchus*, small, snouted beetles or weevils, infest poppy and other seeds. Another weevil, *Dalandria oryza* (Figs. 16, 17, 18), imported from Europe, infests rice and ground roasted acorns. A near relative is the notorious grain weevil, which does great damage to stored cereals.

Leaving the beetles now, the next group of insects important to the pharmacist is that of the moths and butterflies. While we should hardly expect to find moths and butterflies with their long nectar-sucking tubes for mouths, injuring our stores, we do find that these same insects in their young or larval stage, when they are familiar to all as "caterpillars," do not a little injury to our drugs.

The moths, like beetles, go through a strange metamorphosis, and while in the caterpillar stage are provided with strong jaws for eating dry food. All know of the clothes moth, dread foe of the housewife, which, as a small white caterpillar, living in a cylindrical roll or case made from the woolen cloth or fur it is feeding on, does irreparable injury to the choicest fabrics and costliest furs.

This moth belongs to the genus *Tinea*, of which one or more species attack drugs. Figs. 11, 12, 13, 14 illustrate the life history of the moth of this genus. Fig. 13 is the larva or caterpillar, Fig. 14 the case or roll in which it lives, Fig. 12 is the pupa or resting stage, and Fig. 11 is the adult moth The moth is very small and light brown in color. Another moth, known as the Angoumois grain moth (it does great havoc to stored grain in the province of Angoumois, France, hence the name), attacks in the caterpillar stage all kinds of stored grain. It bores holes into the grain kernels and eats out the starchy interior, leaving only a delusive hollow shell. The illustrations, Figs. 6, 7, 8, 9, show its various stages and the appearance of the infested grain kernels. The larva of *Carpocapsa amflana*, a moth of the same genus as the codlin moth, the greatest insect pest of the apple, infests the seeds of *Corylus avellana*, *Juglans regia* and *Castanea vesca*. The larva of *Myelois ceratonia* feasts on the fruits of *Ceratonia siliqua* and *Castanea vesca*. The larva of the moth *Œcophaga oliviella* inhabits the kernels of the olive, causing the dropping of the fruit and a smaller yield of oil.

Passing now to another order of insects, the two-winged flies, we find that while the mouth parts of the adult flies are adapted for sucking or lapping, the young flies, which appear as grubs or maggots, are better prepared to partake of solid food. The olive in southern France and Italy is infested by a larva of a fly known as *Dacus oleæ*; in the kernels of fresh hazel nuts are often found the larvæ of a fly which belongs to the same genus as that notorious wheat pest, the Hessian fly (see Fig. 15). The fly *Trypeta arnicivora* (see Figs. 19 and 20, illustrating a nearly allied species, *pomonella*) is often gathered in its youthful state with arnica flowers and becomes developed later, after feeding on the flowers in the pharmacist's canisters.

About two months ago I placed a notice in the leading pharmaceutical journals of the United States, in which I asked that any insects found destroying drugs should be sent to me in order that they might be studied. As a result, several packages of drugs damaged by insects have been received from different parts of the country, giving an excellent opportunity to pursue the study further. As a result of this latter work I will refer to Plate II.

From P. R. Brooks, of Miles Grove, Pa., was received pressed packages of peppermint, marshmallow leaves, skull cap, wormwood and thorn apple. All of these drugs were infested by a small brown beetle 5 to 7 mm. in length, 2 mm. in width, with longitudinal rows of punctures on wing covers, body above and below covered with fine hairs. This insect is known as *Nicobium hirtum* (see Figs. 4 and 9 for adult and larva). When the insect is disturbed, it feigns death, but soon resumes activity and seeks a hiding place. This insect, as far as we have been able to observe, is one of the worst of insect drug pests.

A small box of pulverized capsicum from D. S. Morgan, Jersey City, also one from J. M. Foy, Worcester, Mass., contained both the adult and larvæ of this brown beetle. Upon examining some drugs in stock in the University's Department of Pharmacy, we found this insect in some roots of a bitter character; also in orris root and ginger root. It is not improbable that this insect may be found attacking any drug containing starch. From Michigan (name of firm and place of residence not given) a package of caraway was received containing the larvæ of some beetles. This larva measures about 7 mm. in length, is white, with pale brown head and body partly covered with short brown hairs (see Fig. 7).

From C. L. Becker & Co., Ottawa, Kan., three packages of drugs injured by insects were received. One of them was a small package of foenugreek, in which was an insect very closely allied to one familiar to housewives of Eastern States, the notorious "buffalo bug." Figs. 1, 2, and 3 show the adult, pupa and larva states respectively of this drug pest. It is *Anthrenus varius*. Its color is black and white; sometimes the white is tinged with reddish yellow. The adult insect lives chiefly on the pollen of certain plants, such as the different varieties of spiræa and those of the shad bush, *Amelanchier canadensis*. Indoors it not only attacks carpets, rugs and woolen goods, but also collections of natural history, furs, hair, and drugs. The larva is more destructive than the adult insect.

The second was a small box of India turnip. The drug came all right, but the insects had cut a hole through the side of the box and escaped. The third lot was a package of condition powers containing the brown insect, *Nicobium hirtum*, just described.

A box of pulverized marshmallow was sent from Philadelphia. In it were a number of small brown beetles. They were 11 mm. long and 2 mm. wide. The long, white larvæ were in the same box, and these are shown in Figs. 10 and 11.

M. Noll, Atchison, Kan., sent an extract of licorice infected with some small white beetle larvæ which are shown in Fig. 6. From the same firm came a box of almond meal in which were a lot of dark brown beetles, *Silvanus surinamensis*. This beetle is shown in Fig. 5, and is easily recognized by the serrated edges of the portion between the head and wings. Its long, narrow body and antennæ enlarged at the tips. Figs. 12 and 14 represent two phases in the life of a moth of the genus Tinea, frequently found flying about among drugs. Fig. 13 shows a little white mite, highly magnified, and seen as small specks on cantharids kept in stock.

So far, only insects attacking drugs proper have been mentioned, but in our investigations we have met some insects that destroy articles not properly called drugs, but always kept in drug stores. For instance, the larva represented in Fig. 8 is that of a beetle which lays its eggs on bone combs. The grub, on hatching, bores its way back and forth through the substance of the comb until the comb is made absolutely worthless. Another beetle attacks horn combs, either breaking off the tips of the comb points or cutting through the side.

Our observations so far have shown: First, that the most destructive insects are the beetles or sheathed-winged insects. With the exception of one moth and one mite, all the insects received at the University and

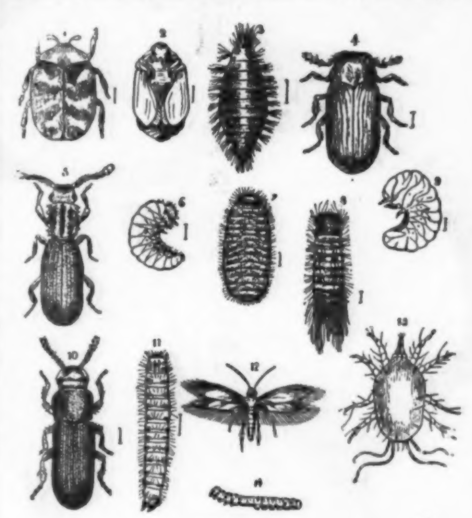


PLATE II.

mentioned in this article are beetles. Second, that the greater part of the drugs attacked and destroyed are vegetables or vegetable products, and hence, that these need the greatest care and watchfulness. Third, that there is need of greater vigilance and more observation on the part of druggists, if these pests are to be successfully driven out. One druggist, when asked if he had ever noticed anything destroying combs, said he had never heard of such a thing; but upon investigating his own stock, he found out of a small lot two combs that were destroyed. Yet he could hardly believe that insects are capable of such work.

I shall have nothing to say in this article as to the means of prevention and the use of repellents such as have been often suggested in current pharmaceutical literature. It is my desire to enter this field of investigation, and anything that the druggists of the United States can do to aid in the matter will be appreciated. Attention must be given to the life history of some of these insects. We should know what materials the insects breed in, what time they deposit their eggs, and make all the observations possible. From these notes a systematic study of the pests can be made, and results of practical value can be obtained. The Swedes, in the time of Linnæus, alarmed at the way in which their ship timber was being destroyed by a certain larva, applied to the noted naturalist for aid. He told them that if they would sink their ship timber in the sea during the month of May, they would be bothered no further by this larva, for the beetle which is the parent of the grub deposits its eggs in the timber in the month of May, and at no other time of the year. If we had a more comprehensive knowledge concerning the habits and life history of insects injurious to drugs, it is very probable that easy means of preservation and prevention of insect destruction might be used.—*American Journal of Pharmacy*.

THE MEDUSA OF LAKE TANGANYIKA.

ALL zoologists interested both in the geographical distribution of animals and their adaptation to peculiar conditions of existence remarked ten years ago the news briefly given by the German traveler, Bohm, of the discovery of a medusa in Lake Tanganyika. Complete information has been awaited in vain since then as to this curious species, which is very common, moreover, as it would seem. In fact, it has been seen again by various explorers, especially by Major Von Wissmann, whose boat was surrounded by these little creatures for nearly half an hour during the course of a trip made April 13, 1887.

The director of the Company of African Lakes has just transmitted to the British Museum some specimens of this medusa preserved in alcohol after having been fixed with osmic acid. It is a graceful organism of discoid form, having a diameter varying from 10 to 22 millimeters, and the greatest thickness reaching about 5 millimeters. The central part of the umbrella, for a space corresponding to two-thirds of the diameter, is inflated toward the interior in the form of a hemispherical lens whose upper rectilinear edge, abruptly attenuated, is inflected in recurving toward the mouth. The latter, widely open, is circular, as is also the stomach. The latter, almost filled by the inflation of the umbrella, is reduced to a small annular cavity.

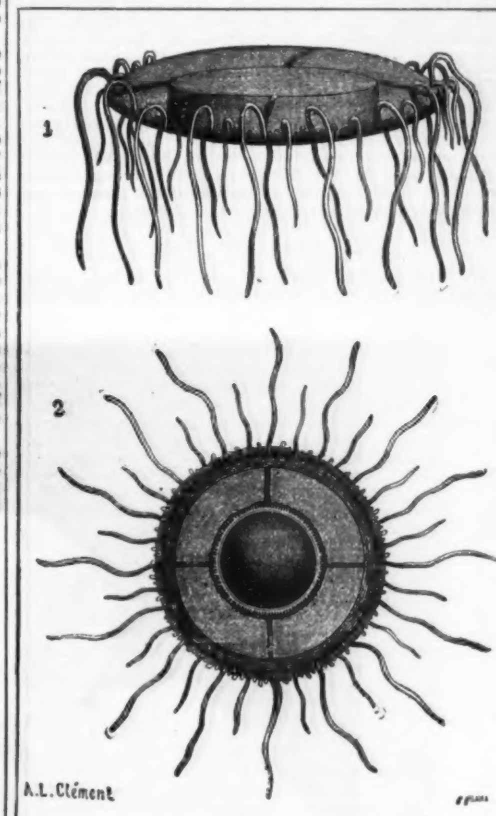


FIG. 1.—THE MEDUSA OF LAKE TANGANYIKA.

1. Side view × 4. 2. View of lower surface × 3.

The majority of the individuals have four radial canals, but it is not rare to find five or six. These canals run from the center of the umbrella toward the periphery in an almost horizontal plane and incline solely to unite at the circular canal.

The number of tentacles exceeds two hundred. In the young the four primary tentacles are distinguished from the others for some time by their larger size; then the difference disappears. These appendages are hollow, and their cavity communicates with that of the circular canal. They adhere at their base, for a greater or less space, according to age, to the external part of the umbrella.

Upon the internal edge of the circular canal, at the base of the insertion of the veil, which is itself well developed, there is a series of irregularly arranged sensitive organs.

The reproductive elements appear upon the manubrium. Besides, some specimens are provided with buds that sometimes seem even to penetrate the gastrovascular cavity.

Mr. R. T. Gunther, the English zoologist, from whom the above details are borrowed, does not pronounce upon the place to which it is well to assign this form in the system of medusas. It becomes, however, the type of a new genus—*Limnocnida*, the species preserving the name of *Tanganyikæ* by which Dr. Bohm first designated it.

Limnocnida Tanganyikæ is the third fresh water medusa made known up to the present. The first was discovered at London in 1880 in the tank of a hothouse of the Regent's Park botanical garden in which are

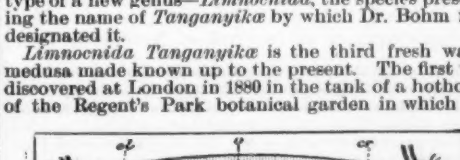


FIG. 2.—THEORETICAL SECTION.

o, umbella; *cr*, radial canal; *cc*, circular canal; *el*, endodermic plate; *mn*, manubrium; *v*, veil; *b*, buds; *s*, sense organs; *t*, perradial tentacle; *t't''*, younger and small tentacles.

cultivated the large Nympheaceæ of tropical America. It received the name of *Limnocodium Sowerbyi*. Its country is unknown. It is supposed to have been introduced with the aquatic plants among which it was suddenly observed. The second, described in 1890, was observed a dozen years ago in a lagoon of Trinity Island, in the Antilles, by Dr. Van Kennel, now a professor at the University of Dorpat. It is the *Halmomises lacustris*.

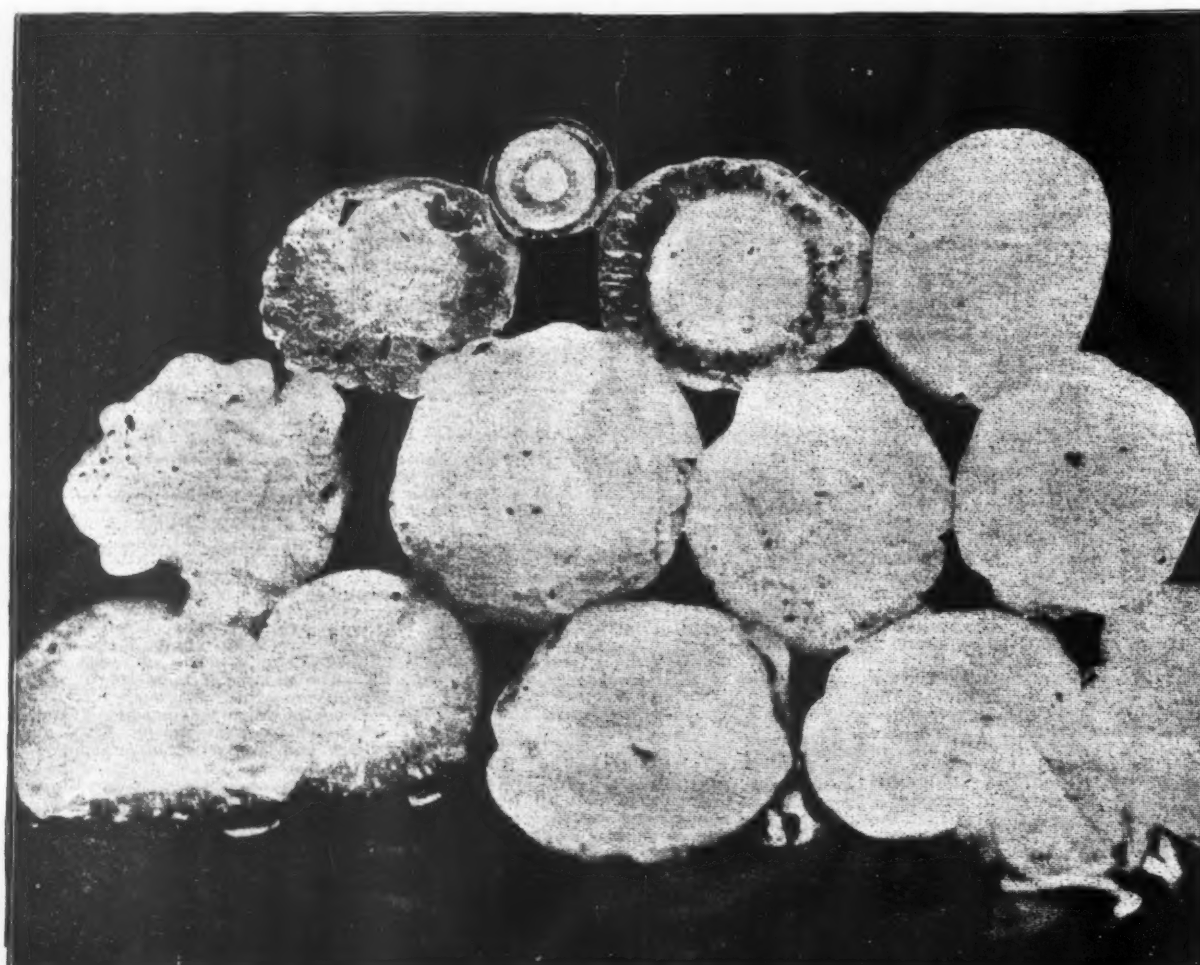
These medusas, like the *Limnocnida*, represent the sexual phase of the existence of a hydroid. The latter

is known only for the *Limnocodium*. It was found at London five years after the medusa whence it is derived and under identical conditions.

It will be remarked that all these Cœlenteræ in question inhabit water that is more or less stagnant at a high temperature. Their vitality, therefore, seems to be greater than that of the true marine medusas (Acalephs). There are, however, among the latter, some that seem to manifest a tendency to adapt themselves to fresh water. Such are the *Crambessa Tagi* and pictonum discovered by Prof. Haeckel at the mouth of the Tagus and Loire, and another species yet undetermined of the same genus, found at Quelimane upon the coast of Mozambique by Dr. Stuhlmann, and which lives in an estuary in which the organic debris give the potable water an earthy color. However this may be, the fresh water Cœlenteræ are as yet few in number. The list of them is closed when we cite the hydras and a few allied types (*Cordylophora, Microhydra*), the singular *Polypodium hydriforme* that lives as a parasite in the ovary of the sturgeon, in the midst of the eggs, and the complete cycle of the existence of which is not yet known, and, finally, the little medusas mentioned above. That of Lake Tanganyika, without speaking of its relatively large size, is undoubtedly one of the most interesting by reason of its habitat in a continental lake situated at more than 8,000 meters altitude, very distant, moreover, from the sea, toward which it flows only in an intermittent manner and through a vast extent of land.—*La Nature.*

A RAIN OF ICE.

ON July 8th last, from half past two to four in the afternoon, an unprecedented storm of wind, rain, hail,



REMARKABLE HAILSTONES (FULL SIZE).

and large blocks of ice occurred at Richmond, Yorkshire.

Being market day, and the storm coming so very suddenly, the market people were driven into all kinds of places for shelter. One batch of women took refuge in the King's Head Hotel yard, when a sudden gust of wind blew them across the flagged footway into the Market Place. At first, rain drops, each as big as a crown piece, fell, then the hail and lumps of ice in size from a hen's egg to an ostrich egg. One lump of ice, ten inches in length, fell against the Convent wall, and the splinters knocked down two boys half dressed who were running home from the River Swale, where they had been bathing. Near the same place a man had a finger broken with a piece of ice. To see the hail and to hear the pieces of ice pierce the windows appeared as though the town was being bombarded. Smash, smash, smash, went the glass for twenty minutes, amid awful peals of thunder and lightning so vivid and red as had never been seen before. More than 100,000 panes of glass (some nearly half an inch thick) have, it is estimated, been broken in Richmond and the immediate neighborhood. Nearly 200 squares are broken in the savings bank, the same number in the King's Head Hotel and Wesleyan Chapel—in fact, all the houses facing the south and southeast have suffered excepting where there was the best plate glass. The center of the large pieces of hail appeared like the pupil of a man's eye. The photograph was taken by Mr. Herbert James Metcalfe, High Row, Richmond, twenty minutes after the hailstones fell.—*London Daily Graphic.*

SIGHTS WITH A FIVE-INCH TELESCOPE.

By GARRETT P. SERVISS.

WHEN I wish to give my friends what I regard as a particular treat, I invite them, on some serene evening, to have a look through my telescope. But I do not invite all of them, indifferently, to partake of this *caviare* of the eye and the mind. I reflect that some of them, having no taste for star gazing, might not honor the invitation with an acceptance, and that others, who would doubtless accept for the sake of politeness, might, after all, be able to see nothing that it did not bore them to look at. So I am very careful with my invitations to these star shows.

Having assembled under the sparkling dome of a summer night two or three friends on whom I think I can depend, I am accustomed to begin proceedings by turning the glass upon that diamond of the sky Vega in the Lyre. If, after the first look, my friends seem indifferent or unmoved, I get them away from the telescope as fast as I can. The revelations of a good telescope are not things to be wasted on unappreciative spectators. The Kohinoor would be no better than a smooth pebble in the hand of a blind man.

Somebody once had a test for determining a reader's capacity to appreciate poetry; it was Milton's "Lycidas." If the reader didn't enjoy that poem, he or she was set down as lacking in poetical taste. In a similar manner, and no less arbitrarily, I judge a man's or a woman's capacity to understand the stars. If they don't find Vega interesting, I conclude that telescopes were not invented for them.

Everybody who knows anything at all of the matter is aware that Vega is a very brilliant star of the first magnitude, and of an exquisite blue-white color, which, in our latitudes, is not far from the zenith between ten and eleven o'clock P. M. in July and between nine and ten in August. It is unquestionably a much greater sun than our own, but, unfortunately, we do not know whether there are inhabited worlds revolving in its blaze. As a matter of simple opinion, however, I believe that those worlds exist.

All amateur telescopists know that hidden in the dazzling rays of Vega there is a minute, eleventh magnitude star, which is called its companion. It seems hardly possible that it can be physically connected with Vega, and yet it doesn't look as though it had got there by the mere accident of being in the line of sight. Formerly, when I used a telescope of only 3¾ in. aperture, I did not often succeed in showing this little star to my friends; in fact I could not always see it myself. But this summer I have procured, through Messrs. Gall & Lembke, a five-inch telescope made for me by the master hand of Mr. John Byrne. The making of a first-rate object glass for an astronomical telescope is an art so rarely carried to perfection that it is only the plainest justice to give credit to the few men who can do it. With this Byrne five-inch glass, then, I have now no difficulty in showing Vega's little companion to any one who chooses to look at it. Of course, however, this is no test for a five-inch telescope, and I mention the matter here only because the seeing of that little star adds surprisingly to the charm of looking at Vega. Then, too, the clearness and ease with which it is seen, and the telescopic perfection of Vega itself when carefully focused, are an unending delight to the eye.

There are several things about the glass in question which seem to me worthy to be recorded. In the first place, the focal length is only 52½ inches. The ordinary focal length of a five inch object glass is in the neighborhood of 70 or 75 inches. One great advantage gained by thus shortening the focal length is that the telescope becomes much more easy to handle when it is desired to use it on a movable stand. The comparative brightness of objects is also increased, while the apparent disks of stars are diminished. But as the proof of a pudding is in the eating, so the proof of a telescope is in the seeing.

Let me mention a few of the things that can be seen with this glass. I am not speaking now of what only a practiced eye can perceive under exceptional conditions of air and weather, but of what I have had the satisfaction of showing to persons who have had little or no experience with telescopes, and in ordinary atmospheric circumstances.

Antares, the bright red star in Scorpio, is a double that amateurs do not often succeed in separating. The difference in magnitude of the components (the large star being of the first magnitude and the small one of the seventh) and the nearness of Antares to the horizon, combine to make this a difficult object. With the five-inch I have never failed to see the companion most clearly and beautifully on every night that I have tried it. Even when the great star appears a mass of crimson flames, flashing and coruscating with unceasing motion, its little bright green comrade is easily visible, and when the air steadies the sight becomes one of the most beautiful I have ever beheld. I should be inclined to transfer Admiral Smyth's title of "pulcherrima" from Epsilon Bootes to Antares. The distance between the companions is nearly the same, about 3", in each case, and there is a similar contrast of colors, but Antares is, of course, a far more difficult object than the other.

Many an amateur telescopist has strained his eyes to catch a glimpse of the celebrated "debilissima" (two minute stars of twelfth and thirteenth magnitude respectively) which lie between the two beautiful pairs composing the "double-double" Epsilon Lyræ. With the five-inch these delicate objects are so conspicuous that, in anything like good atmospheric conditions, the most inexperienced eye sees them at once.

The "eagle-eyed" Dawes, one of those English clergymen who have made a specialty of amateur telescopy, set down a rule by which to determine the excellence of a telescope in separating double stars. He found that a one-inch glass should just separate stars 4·56" apart, and his rule asserts that the separating power of larger glasses may be determined by dividing the number 4·56 by the aperture of the telescope in inches.

This rule of Dawes is generally looked upon as supplying severe tests. According to it a five-inch of first-rate quality should just separate a double star 0·91" apart. There is a star of exactly that distance in Ophiuchus; it is number 2,173 in Struve's catalogue. The first time I turned my five-inch upon that star the seeing conditions were certainly not above average, yet the star was separated with perfect distinctness. It is a pleasure to look at the two little round disks (they are of sixth magnitude) side by side, very close, and yet so sharply cut that the sky between them shows black and clear. Anybody with average eye-

sight sees the duplicity of the star at first glance. It is perfectly evident that Dawes' rule does not furnish a maximum test for this telescope.

In Bootes there is a well-known triple star named Mu. Two of the components are very wide. The smaller of the two is a binary, the distance between whose stars is at present 0·85". In fair seeing weather this close binary is not a difficult object with the five-inch. I am confident that with a fine atmosphere I could separate stars only 0·75" apart.

So much for double stars. Now for a word about star clusters and nebulæ. The Ring Nebula in Lyra is too faint an object to be satisfactorily seen with a telescope of less than five or six inches aperture, although I have had interesting views of it with three and three-eighths inch. With the five-inch it is beautiful; a delicate oval, faintly sparkling, as though composed of the finest conceivable gauze sprinkled with diamond dust. The minute star close to one end of the nebula adds to the interest of the sight.

The great star cluster between Eta and Zeta Herculis—that marvelous congregation of suns, in the midst of which a sort of perpetual daylight must prevail—presents itself in the five-inch as a splendid phenomenon, startling the eye with its strange beauty. Multitudes of tiny stars are revealed, running at the center into an inextricable maze, while radiating in all directions from the central mass appear long waving lines of stars, which have been thus arrayed by some marvel of creative power.

It is not easy to describe the views which the same glass has furnished of Saturn. The rings are now turned so nearly edgewise toward the earth that their apparent minor axis is in the neighborhood of only 4". Yet the principal division in the rings is clearly visible near the ends of the ansæ, and the difference in brightness of the inner and outer ring is conspicuous. The shadow of the rings on the planet is beautifully defined, and the planet itself presents no little detail, the equatorial regions being of a light yellow color, while toward the north a shade overspreading the globe gradually deepens until around the pole it assumes a faint steel-blue tint. Several of the satellites are to be seen on any evening circling about the great ringed wonder that governs their motions.

I have mentioned these various objects, among the multitude that the heavens present, in the hope that amateurs, on learning how much can be seen with comparatively small means, will be encouraged to use the telescope until it has become as common an instrument of intellectual recreation among the cultivated families of the United States as it is among those of England.

THE VICTORIA REGIA.

THE great water lily of the Amazon still holds first place among the giants of the vegetable world which have been introduced into gardens. Other giants come and go; the titanic Amorphophallus flowered once at Kew, died two years after, and is now no more except in its home, the swamps of Sumatra; big Wellingtonias, Eucalyptus, palms, and other giant trees we know only from pictures, and the big Rafflesia from wax models; but the Victoria remains with us after nearly fifty years' acquaintance, and it can be grown to the same dimensions in a glass house in Europe as it attains in the tropics under the most favorable of natural conditions. In England it may be termed an expensive plant, as it requires a specially constructed house and large tank, with a tropical temperature maintained at not less than 70°, and in some seasons at 80°; but it is worth the cost of its cultivation. The Botanic Garden of Kew without the Victoria would be shorn of as much interest as the zoo would be without an elephant or a hippopotamus. The large leaves resting on the water, the beautiful fragrant flowers, and the exceptionally rapid development of the plant from a seed into full size within a period of about four months, these are characters which invest the Victoria with a special interest for lovers of plants. There are only two gardens in London in which the Victoria can be seen, viz., Kew and the botanical garden at Regent's Park. Mr. Abraham Dixon, of Cherkley Court, Leatherhead, is perhaps the only amateur in this country who cultivates it. It used to be grown in the botanical gardens at Oxford, Sheffield and Birmingham. In my opinion, no public garden with any pretensions to an indoor collection of plants ought to be without a Victoria as a summer attraction. The largest tank I know of is in the Zoological Botanical Garden at Rotterdam, where three plants are grown, and where the leaves are so large and strong that three children from about ten to fourteen years of age have been supported by one leaf. It is also exceptionally well grown in the Royal Botanical Garden at Glasnevin.

The seeds of Victoria are kept in water always in a temperature of about 60°. They are sown in February in pans of soil placed in water kept at a temperature of 85° to 90°. As soon as the plants are large enough to handle, they are planted singly in pots in a richly manured soil, and the water is kept at the same high temperature. In April the large tank is prepared. About six cart loads of loam and cow manure are placed in a pit in the middle of the tank, which is then filled with water, and heated to 80°. The plant is then placed in the soil at a depth of about one foot below the water. The house in which the tank is placed should be kept well ventilated, and top air left on all night in mild weather. By the end of June the plant should be nearly full size, and it will flower soon after. Seeds are matured by plants cultivated at Kew. Some time ago we heard of a purple flowered Victoria which had been discovered in South Brazil, and was called V. argentinensis, but on inquiry it turns out to be nothing more than a form of V. regia with a deeper tinge of crimson on the petals than usual. There is only one species of Victoria, and it is now cultivated or naturalized in most tropical countries. Its near ally Euryale ferox, a native of India, and remarkable for the hooked spines on the upper surface of its large leaves, and for its small purplish flowers, is grown at Kew in the same tank as the Victoria.

The structure of the leaf of Victoria is a remarkable instance of adaptation to circumstances. The under side is clothed with strong spines, which protect the leaves from aquatic animals; and to protect the upper surface, the margin is turned up all round, forming a rim several inches high, the outside of which presents a spine-clothed barrier to any swimming animals which might otherwise land on the leaf. The leaf is, therefore, a large round tray or shallow dish. Last year we tried the effect of pouring a quantity of water into one of these dishes, and although the leaf was intact, and the rim perfect, the water mysteriously escaped from the leaf as fast as it was poured into it. On closely examining it, we found the whole leaf was perforated with innumerable pinholes, no doubt intended to prevent the leaves from being practically submerged through filling with rain. The leaves when young are folded involutely, and are protected by the spines of the under surface. The stalks of both leaves and flowers are thickly clothed with sharp spines. To prevent the leaves from crowding, the stalks continue to elongate long after the blade has matured. In Euryale, the leaf, which is nearly as large as that of the Victoria, is rimless, but protection is afforded to it by spines on the upper surface as well as below. *W. W.* [Our illustration is from a sketch taken at Kew by the late Mr. W. H. Fitch. On one of the leaves are shown, for the sake of contrast, the flowers of the large Australian blue water lily, Nymphæa gigantea, large indeed, but small in comparison with the Victoria.—ED.]—*The Gardeners' Chronicle.*

VICTORIA REGIA, ROYAL GARDENS, KEW.

A COCOA APPEAL CASE.

AT the Glamorganshire quarter sessions on June 29 before Mr. J. Coke Fowler and Judge Williams, Mr. Thomas Jones, grocer, appealed against a conviction by the Ystrad magistrates under the Sale of Food and Drugs Act. On December 22 last, Superintendent Jones purchased from the appellant a packet of cocoa, for which he paid 2d. He then stated that he had bought the cocoa for the purpose of analysis, and offered to divide it, but the appellant declined the offer, observing that he bought the packet as cocoa and that he sold it just as he got it. The county analyst certified that it consisted of 30 parts cocoa and 70 parts starch and sugar. It was admitted that the cocoa did not contain pure cocoa, it was what was known as Fry's pearl cocoa, but Mr. Lewis, for the appellant, contended that the seller was protected by a label containing these words: "Contains cocoa combined with other ingredients, the perfect purity and wholesomeness of which are guaranteed in accordance with the Act of Parliament." Respondent, however, said that when the packet was handed to him this notice was entirely concealed by the wrapper of white paper, and it was submitted that this circumstance took the packet entirely out of the act. According to the 8th section of the act, the notice must be distinctly and legibly written or printed, so that it could be seen by the customer at the time of purchase.

Judge Williams considered it was the business of the respondent at the time he bought the packet to see what he was getting. He could have asked the appellant before wrapping up the packet to let him see what was on the label.

Mr. Stephen, for the respondent, further contended that the 70 per cent. of starch and sugar was fraudulently added to the cocoa in order to increase its bulk. This was strongly combated by Mr. Lewis.

Mr. Joseph Fry, of Messrs. J. S. Fry & Co., cocoa manufacturers, Bristol, said that the respondent got for his money within a fraction actually twopennyworth of pure cocoa, plus the sago and sugar. This pearl cocoa had been in the market for between thirty and forty years, and the ingredients of which it was composed had been substantially the same during its entire manufacture. He said the sufficiency of the notice on the packet had never been successfully questioned in any court of law. The sugar and sago were added in order to make the cocoa easily soluble in boiling water.

After conferring together, the chairman said the court were divided, and the decision of the justices below would therefore stand. Mr. Lewis asked for a case on the two points raised, the sufficiency of the notice and the alleged fraudulent addition to increase the bulk. This was granted, costs to abide the appeal, but in the event of the appeal not being proceeded with, costs to be borne by the appellant.

NEW CELLULOSE DERIVATIVES AND THEIR INDUSTRIAL APPLICATIONS.*

By C. F. CROSS, E. J. BEVAN, and C. BEADLE.

WE have recently published (*Chem. Soc. J.*, 1893, 837) a brief account of a new series of synthetical derivatives of cellulose, produced by the interaction of alkali-cellulose and carbon disulphide. The reaction may be formulated as under, using the symbol X to represent the reacting cellulose unit or residue:

$$\underset{\text{Alkali-cellulose.}}{X.ONa} + CS_2 = \underset{\text{Cellulose-xanthate.}}{CS\left\langle{\begin{matrix}OX\\SNa\end{matrix}}\right.}$$

and the reversal of the process or decomposition of the product, which is readily determined in presence of water, may be expressed with equal simplicity as—

$$\underset{\text{Cellulose-xanthate.}}{CS.{\begin{matrix}OX\\SNa\end{matrix}}} + H_2O = CS_2 + \underset{\text{Cellulose.}}{X.OH} + NaOH$$

The purpose of this communication is to describe these reactions somewhat more in detail, and to indicate some of the industrial developments which are opened out by the recognition of this particular synthetic capacity of cellulose. At the same time it is a duty we owe our colleagues, not to present the subject in any narrowed or exclusive view of utility, and we shall rather attempt its treatment from the broader view of cellulose technology, as the adaptation to more or less similar uses in the arts of the structural materials which nature employs in the plant world in endless variety and quantity. Our methods of working up cellulosic raw materials may be conveniently classified as mechanical and chemical. In the former we may include textile manufactures and paper making; for any chemical treatments which are involved are designed to produce the minimum of change in the fibrous basis of the raw material, and are in fact merely auxiliary to the preparation of these in suitable condition. In the latter we include all processes based upon a definite chemical change wrought upon the raw material. Such processes are few in number, and, in relation to the former group, of minor importance. Confining ourselves to those which produce fabrics or structural materials, we may cite (*a*) the applications of the cellulose nitrates to the production of materials and goods known as celluloid, xylonite, etc.; and (*b*) the conversion of cellulose—in the form of fabrics—into hydrated modifications having special properties, *e. g.*, by treatment with strong alkaline solutions (mercerization), or with strong acids or zinc chloride solution (parchmentizing), or the production of an actual solution of cellulose and applying this in various ways, as in the processes of the "Willesden" Company. It is unnecessary for us to say anything as to the value or the defects—the net value if we may so speak—of the products of these processes. One conclusion, however, we are entitled to draw from the enormous amount of practical research which has been devoted to cellulose in the working out of these processes, that is the recognition, in this raw material of the natural world, of "plastic" capabilities of a high order, and requiring only the right treatment, *i. e.*, chemical modification, to enable us to follow nature in working it up into endless varieties of form and substance. It strikes one as not a little remarkable that the search for a plastic modification of cellulose itself appears to have been entirely shelved, assuming it to have been entered upon by the discovery of similar properties in its nitrated derivatives, and by the many ingenious and valuable developments which have resulted from this discovery. Of these perhaps the most interesting from our present point of view are the attempts, more or less successful, which have been made to spin these nitrated products from their viscous solutions in special solvents into the form of a continuous cylindrical thread. The "artificial silk" so produced by the process of Dr Lehner, and of which specimens are submitted, manufactured during a recent demonstration of the process in London, affords the most perfect illustration of the plastic properties of these nitrated celluloses, and also of an important property of the cellulose molecule itself, viz., that of preserving its essential characteristics through such considerable variations as are involved in combination with nitric acid in large molecular proportions.

In investigating the thiocarbonic esters of cellulose we have been still further impressed with this property or characteristic of preserving its molecular integrity through a series of reactions of an equally severe order, but in direct antithesis to those involved in the treatment with the powerful acid mixtures used in nitration. The alkaline thiocarbonates of cellulose are produced by direct synthesis in two stages: (1) the fiber is treated with strong solution of the caustic alkali at the mercerizing strength, *e. g.*, a solution of NaOH of fifteen per cent. The product may be conveniently termed alkali-cellulose, and the proportion of the reagents giving the best results may be expressed in the simplest terms by the ratio, $C_6N_{10}O_5 : 2NaOH$; (2) this alkali-cellulose is exposed to the vapor of carbon disulphide in a closed vessel, reaction ensues, and in the course of 2—3 hours a yellowish mass is obtained, which dissolves in water to a solution of enormous viscosity. The proportion of CS_2 used is expressed by the ratio $CS_2 : 2NaOH$. In regard to the composition of the product so obtained, we have shown (*loc. cit.*) that it must be considered rather as a thiocarbonate of the alkali-cellulose residue which may therefore be expressed by the general formula—

$$CS\left\langle{\begin{matrix}OX.ONa\\SNa\end{matrix}}\right.$$

It will be noted that powerfully deoxidizing conditions are superadded to the hydrolytic action of the alkali throughout this reaction, and the fact that the cellulose molecule withstands the combined and prolonged assault of the alkali in concentrated solution and alkaline sulphocarbonate is an important point of evidence as to its constitution.

This power of resisting disintegration is an expression of the general inertness of the cellulose molecule, but in the reaction which we are studying this becomes rather a positive property of integration or aggregation. This point we illustrate by a brief notice of the conditions under which cellulose is regenerated from solution of these thiocarbonates or xanthates. After the synthesis of the compound is completed on the lines above described and in presence of excess of water we have a swollen mass of bright yellow color—this color being due to by-products of the reaction, viz., tri-thiocarbonate. In further combining with water the mass behaves and must be treated very much like gelatin, excepting that solution completes itself spontaneously, and requires no application of heat. From this crude solution we can precipitate the cellulose sodium xanthate by suitable dehydrating agents; the best results being obtained with common salt and with alcohol. In using the former we find it best to coat a glass plate with the viscous solution and submerge in brine. A thin coating is solidified in a few seconds to a continuous film of the purified substance in a hydrated condition, which has a greenish color, is very elastic, and of course readily redissolves in water. This precipitation has been carefully studied and yields, as we find, a continuous series of products in which the ratio of alkali to sulphur remains as in the original reaction, viz., $Na_2O : S_2$, but with a diminishing ratio of both to the cellulose. Thus starting at the percentage ratio—[Cellulose = 100]—100 : 38 we have obtained soluble compounds, having a ratio 100 : 4, and every intermediate stage has from time to time been observed. Even at the ratio 100 : 2 the compound gelatinizes with water and passes into a condition of semi-solution. If, therefore, we take the reacting unit of cellulose, in the first instance, as $C_6H_{10}O_5$, the unit in these later stages of solubility must be from ten to twenty times these dimensions. In fact we have no evidence of any break of continuity in passing, by this extremely simple method of decomposition, from the xanthate synthesized according to the equation to cellulose itself, obtained of course as a gelatinous hydrate.

The precipitating action of alcohol follows a similar course, but the decomposition of the xanthate is much more gradual under its action.

For industrial purposes the salting process fulfills a wide range of requirements, enabling us at small cost (1) to isolate the soluble compound from the by-products of the reaction—sodium trithiocarbonate, etc., and to prepare it in any convenient form, such as films or threads; (2) to fix the compound upon any surface, or (3) to fix the compound in any of the stages of dissociation or decomposition above indicated, terminating in the insoluble condition in which it approximates in composition to cellulose itself.

The tendency of cellulose to aggregation, which is the theoretical point we wish to emphasize, is still further demonstrated by the properties of the solution of the sodium compound itself, which we may now consider in the purified state. The viscosity of these solutions is quite remarkable. A 7 per cent. solution of the compound, *i. e.*, containing say 5 of cellulose to 100 of water, has a viscosity equal to that of glycerin, measured by rate of flow.

It cannot be considered a constant property, nor, indeed, is this to be expected. With the same cellulose, *e. g.*, cotton, the viscosity varies considerably with the method of preparation, and, of course, with the actual composition, *i. e.*, ratio of cellulose to alkali and sulphur in combination, of the compound in solution. We cannot at this stage attempt to express the physical properties of the solution in specific terms. Putting the matter generally, it results from these observations, added to countless others which have preceded, that cellulose has an exceptional capacity for solidifying water. In the solutions of these soluble derivatives we are dealing with a series of transitions to the condition of an insoluble jelly of the regenerated cellulose; such transitions in physical condition in the case of many other colloids, *e. g.*, gelatin and soap, are determined by changes of temperature, but in this case are the expression or result of chemical change. Without, therefore, any attempt at a precise definition of the terms, we may describe the solutions of the compounds with a high alkali and sulphur ratio as *viscous*, with a low ratio as *gelatinous*.

We must now turn our attention to the decompositions of the xanthate, which have been already alluded to.

As the compound may be considered as formed by the synthetical *association* of alkali cellulose and carbon disulphide, so the decomposition which ensues spontaneously may be taken as the corresponding *dissociation* into carbon disulphide and alkali cellulose. When the purified compound is kept in the dry state this decomposition is realized, though very gradually, with only slight complications due to secondary reactions.

This property, of course, constitutes a limit to the usefulness of the compound in one direction, at the same time that it is the essential condition of what are, without doubt, its most important applications.

The decompositions in presence of water are very gradual at the ordinary temperature, and are complicated by the formation of alkaline thiocarbonate by secondary interaction between the carbon disulphide and alkali. The rate of decomposition remains slow at temperatures below 60°, and, in fact, the solutions, in thin films, may be evaporated to dryness at 50° to 60° without sensibly prejudicing the solubility of the compound. At 70° to 80° we approach the critical temperatures of the compound, and at 80° to 90° the decomposition may be considered as instantaneous. These resolutions, which have the simple character of dissociation, have the advantage of regenerating cellulose in a form in which it is easily freed from alkaline compound by merely washing. The sulphur remaining after thorough washing is very small in amount, and the last traces are easily removed by light oxidizing treatment.

Certain characteristics of the final stage of the decomposition, *i. e.*, the regeneration of cellulose, have now to be noted. The spontaneous gelatinization of the solutions appears to take place without change of volume, the coagulum invariably reproducing the details of the surface of the containing vessel. Shrinkage then ensues, the form of the coagulum being perfectly retained. Solutions exceeding 10 per cent. strength (cellulose) give a coagulum of great solidity; even when diluted to 0·5 per cent. strength the cellulose jelly obtained has sufficient consistency to be handled.

The variety of solid forms of cellulose obtainable by means of these solutions is considerable. From the finest films to solids resembling horn, all grades of variation in substance can be obtained. From the properties of the solution its various possible applications will be readily inferred by technologists. It is not our intention to deal with these at all in detail, merely indicating those which have been found workable.

(1.) As an adhesive substance—substituting glue, flour, paste, gums, India rubber solution, etc. The solution has been successfully used for such "inferior" purposes as bill sticking and for the more refined operations of book binding.

(2.) For sizing and filling textiles. Beginning with the sizing of cotton warps, we have tested a variety of applications in this province, including the operations of "finishing" cotton and linen cloth. In this direction the important advantage of depositing a substance of the same chemical composition and physical properties as the material of the textile does not need to be insisted upon. Moreover, the filling can be carried out at a stage in the bleaching process, *e. g.*, immediately after the "heavy" treatment with boiling alkalies. The cloth having in this treatment undergone from 35 to 95 per cent. of its total loss of weight, *i. e.*, substance, the cellulose can be deposited upon a basis of pure fiber, *i. e.*, an approximately pure cellulose, and when deposited and fixed as above described perfectly withstands the subsequent actions necessary for the whitening or bleaching proper of the fabric. We have in this way introduced from 15 to 30 per cent. of additional cellulose without the possibility of its presence being appreciated except by comparison with the unfilled fabric, which it need hardly be said is very much to its disadvantage.

(3.) For purposes of producing casts and moulds. By coating surfaces with the solution or filling hollow vessels, perfect reproduction of form and structural details can be obtained in the form of a more or less solid mass of cellulose (hydrate). Shrinkage is very gradual when the solutions employed exceed 10 per cent. in strength, and in presence of water tends necessarily to a limit, the mass still remaining a hydrate with a considerable ratio of water to cellulose. The cellulose, when fully dried (dehydrated), forms a transparent mass resembling horn, which can be worked in the lathe, taking a brilliant surface under the cutting and polishing tools.

(4.) The applications of the various forms of the solid cellulose, solidified, *i. e.*, in film or block form, will be evident to any one who handles them, and their destiny in this direction must resolve itself rather on such questions as cost of production.

Many other possible applications will no doubt occur to specialists and will arise in the course of the development of the matter. Those that we have cited are a sufficient illustration of the general principles involved, and we may conclude this portion of our exposition with a few practical demonstrations of the properties of the solution.

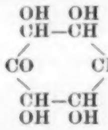
We revert to the rather more theoretical questions involved in the problem of the constitution of cellulose. In regard to this particular reaction, it must be noted that from a given weight of cellulose dissolved as thiocarbonate and regenerated, either spontaneously or by decomposition with acids, (1) the product obtained shows a slight increase upon the original; there is, therefore, no evidence of hydrolysis of the cellulose molecule, and (2) the regenerated cellulose, with the exception that the empirical formula corresponds with a hydrate of the original, viz., is similar in chemical properties, and may be considered as identical in all the negative characteristics by which the normal cellulose is distinguished.

It follows in a very distinct way from the study of the decomposition of the thiocarbonate solutions that cellulose is proximately an aggregate of great complexity. We do not refer, of course, to the complexity of the visible structure of cellulose; what the properties of the molecule may be which condition this species of configuration is a very far off problem. We refer to the aggregation of the reacting units into groups of large dimensions, the proofs of which have been sufficiently given above. Having shown that the reacting unit is of variable magnitude in the one direction, we may conclude conversely that the simplest unit is a C_6 group, *i. e.*, either $C_6H_{10}O_5$ or $C_6H_{10}O_5mH_2O$, for the reason, among others, that there is no evidence for assigning any other limit, such as a C_{12} formula. It is true that the formula $C_{12}H_{20}O_{10}$ is convenient, since it enables us to avoid fractional expressions for the composition of many of the derivatives of cellulose, and it may be used in all cases where nothing is implied as to the ultimate reacting unit of cellulose. But with regard to this unit it appears more than probable that it is of the dimensions of C_6.

In the lignocelluloses—notably jute—the differentiating groups are certainly of the keto. R. hexene type, and there is a weight of evidence to show that the cellulose groups, if not of this type, readily pass over into the cycloid or closed ring. In fibers of this class the ease with which derivatives of low molecular weight are obtained impresses us with simplicity of ultimate composition, although the simple constitutional units may be and no doubt are put together in extremely complex configurations. We cite this instance, how-

* From the *Journal of the Society of Chemical Industry.*

ever, only for the purpose of showing that there is no *a priori* improbability in the view that the ultimate groups, of which the cellulose molecule is made up, may also be of simple type. If this view is taken, we have then to search for the connecting "bond" or "link," which must necessarily be of the C—C or C—O—C type. From what we know of the function of the latter grouping in the carbohydrates, we should expect to find it correlated with extreme susceptibility to the action of hydrolytic agents. Now, cellulose is not only resistant to hydrolysis, even when aided by powerfully oxidizing and deoxidizing conditions, but, as we have shown, shows the very opposite tendency, viz., to build up reacting units of very large dimensions. This is a fact which must be accounted for, and we submit the following as a working hypothesis, which certainly contravenes none of the evidence which has been accumulated up to the present; that cellulose is made up of unit groups of the type—



and that the linking of these groups into complex molecules is effected by the union of CO to CH_2 in which there is a transition to the form CH—C(OH). The synthesizing functions of this grouping are a conspicuous subject of modern systematic investigation, and there is every temptation to regard it as a probable factor in the building up of carbon compounds by the plant. Whether it play the part in cellulose chemistry which we are inclined to assign to it, further investigation must show.

This is not the occasion to extend the discussion of these more theoretical points. It is quite clear, however, that if we are to have a development of cellulose technology, which is to be a following, however humble and "afar off," of the revelations of the plant world, we must continue to work from the strictly theoretical standpoint. It is from this point of view that we have been careful not to ignore the important problem of the actual constitution of the cellulose molecule.

DISCUSSION.

The chairman said it had been a great treat to listen to this paper, which opened up a field for industrial work of the most ample dimensions. As it was so late he would content himself with putting one or two questions. In the first place he would ask how these films behaved if used for dialysis, and also whether the specimens shown were really free from water except that present as hydrate; whether such solids would undergo any further shrinkage so as to develop cracks or fissures, either by loss of substance or by twisting so as to render the solid unsound. It also occurred to him to ask whether the regenerated cellulose could be passed again through the same series of reactions if the operations described were repeated upon it, and whether it was subject to any change on mere exposure to water. Perhaps it might be used for the formation of a sort of paper, which would be—not waterproof in the sense that it would not allow the water to pass through it—but which would be indestructible by water; whereas ordinary paper, in which the fibers were merely felted together, became so tender on exposure to water that it was practically destroyed.

Mr. Royle asked whether the authors made any experiments with respect to the affinity of this substance for coloring matters, and whether it gave any clew to the action of dyes on fabrics, whether it was mechanical or chemical.

Mr. Watson Smith said one very important point touched upon in the paper was the treatment of cotton cloth by this method. If anything could be done to abolish the practice of filling cotton with China clay and other weighting materials, it would be an exceedingly good thing. He believed that Lancashire cotton was sent to India and sold there by weight, which might account for the tendency of manufacturers to put in these heavy substances. This cellulose would not add much to the weight, and if some important property could be conferred upon the cotton by treatment with it, it would be a good reason for adopting it and it might lead to the disuse of China clay. To give an illustration of the immense viscosity and tenacity of this substance, he might mention that Mr. Cross kindly gave him a small quantity of a 5 per cent. "viscose" solution, a little of which he, on one occasion, got over his hands. An insoluble skin or film was quickly formed, and he found it utterly impossible to remove this by washing with cold acid water, and almost so with hot water and soap. Finally, he had to use sand and pumice stone along with soap.

Mr. E. F. Hooper asked whether these films would do for photographic purposes. It looked as if there might be a great future for this sort of thing. He should also be glad to know if it would stand the action of chemicals, as it might come in very useful for chemical operations and apparatus.

Mr. De Mosenthal said this was quite a new subject to most of them, and, of course, opened up the large question of the nature of cellulose and of the cellulose molecule. He had had the advantage of being allowed to cut a little disk off one of the specimens and put it under a microscope, when he found it looked very much like celluloid in section. This new substance would probably have an enormous advantage over celluloid, which was exceedingly inflammable, while this was not, but it would require a great deal of study before any one could know much about it. It seemed to be exceedingly similar to celluloid, but without its disadvantages.

Mr. Guttmann said of course Mr. Cross could not have completed his experiments on a new material like this. He should like information on two points; first, whether the solid mass, which could be turned and polished, retained its elasticity, or whether it became brittle, and secondly, whether it became electrical on rubbing.

Mr. Cross, in reply, said that forms in which the solid products have been submitted might be considered fully dehydrated and permanent. A certain degree of elasticity was a permanent property of the cellulose. The elasticity of the partially dehydrated products appeared to be preserved in contact with water. With regard to the resolution of the regenerated cellulose, he supposed the chairman had in his mind the question whether its constitution was that of the normal. It was found in effect to behave under treatment by the synthetical process described exactly as the normal. With regard to the relations of this form of cellulose to coloring matters, and the theory of dyeing, this was a matter under investigation and requiring very systematic study. So far the substance appeared to show more basic properties than the ordinary cellulose, and it had a fairly free "affinity"—for want of a better word—for the azo coloring matters. The application of the ferric ferricyanide reaction also gave interesting results. The xanthate films treated with this reagent gave a perfect deposition of Prussian blue without affecting the continuity or translucency of the film. It was, in fact, a complete drying of the material with soluble Prussian blue. Mr. Smith's strictures upon the Lancashire trade were, to a certain extent, justified, but it must be remembered that there were conventions governing all trades, and he believed no one would be better pleased than the manufacturers to get rid of the practice of heavy weighting with China clay and similar materials. They had no particular fancy for putting these things in, but they were demanded by certain markets. With regard to the possible application of this substance to photography, this was a development of the greatest interest, and was under careful consideration. For that purpose there was wanted not merely translucency, but a pretty high degree of transparency; when that was obtained no doubt the substance would fulfill a much larger range of requirements. With regard to chemical inertness, it had all the resistance and rather more than cellulose itself. With regard to electrical properties, they had investigated its insulating capacity. They had compared a film of this substance about $\frac{1}{10}$ of an inch with paper and vulcanite, and found that the insulation was very much in the ratio of the normal hygroscopic moisture of the substances, somewhat to the disadvantage of this material. This had rather higher hygroscopic moisture than ordinary cotton, viz., 10 per cent., while cotton paper would be about 7½, and vulcanite practically *nil*. The insulating capacities were inversely as the hygrometric moistures. When perfectly dehydrated it was, of course, capable of holding an electric charge. With regard to the permanence of the solid, they had now kept slabs for many months, and put them through all kinds of operations, and had come to the conclusion that the amount of tenacity shown in the solids was the true property of the cellulose molecules when solidified in that continuous form.

SOCIETY OF CHEMICAL INDUSTRY.

THE annual general meeting of this society began July 12, 1893, at Liverpool. The Victoria Buildings, University College, having been made the headquarters, Mr. E. C. C. Stanford, president, proceeded to deliver his address.

While pointing out that it was only by co-operation that British industry could prosper, as almost every industry overlapped another, and nowadays chemistry played an important part in so many branches, the president briefly reviewed the relations between inorganic and organic chemistry, indicating the rapid and almost revolutionary advances made by organic chemistry, though the changes in inorganic chemistry had not been extreme. He further called attention to the rapid advances made in the study of *spectrum analysis*, making special mention of the work of Norman Lockyer and Mr. Huggins. Regarding *electricity*, it was hard to say whether that science did not owe as much to chemistry as chemistry did to it. While chemistry was called upon to assist in the production of the electric light, electricity had also placed greater intensities of heat at the command of the chemist than could be derived from ordinary sources.

The study of heat irrespective of electricity, however, had largely reacted on chemistry.

In the other direction—the absence of heat—Professor Dewar had during the present year made most important advances. Although air had previously been liquefied, he had now been able, by means of intense cold alone, to reduce atmospheric air to the liquid condition. His further results, by a combination of enormous pressure and extreme cold, were well known, and now that oxygen and hydrogen had yielded themselves to the advances of science, and had been obtained in quantities in a liquid state, it was hard to say that hydrogen was destined always to remain intractable.

These experiments, in conjunction with others carried on in France, made it seem possible that what might be termed "glacial chemistry" would eventually enlarge their views as to the various properties of matter.

Since the introduction of *artificial light* much had been done. At the present time gas had to compete with electricity as an illuminant, while in many cases it had been superseded by mineral oils, which were now so abundant and cheap, and of which in that society the flashing point might be said to be almost a burning question. If, however, gas was losing ground as an illuminant, it seemed to be gaining it as a source of power, and there were prospects of a considerable increase in the use for this purpose of hydrogen and its compounds, containing far less than ordinary coal gas.

Coming to *metallurgy*, the president referred principally to the improvements in the cheap production of aluminum (and in connection therewith the manufacture of metallic sodium), and the manufacture of rubies, which, though unable to rank as gems, were suitable for "jeweling" watches.

Turning to organic chemistry, the speaker compared the situation in 1840 with that of to-day, and though such vast changes had been made, pointed out that it was some satisfaction to know that the woad with which the ancient Britons stained their bodies was still cultivated among them for the purpose of dyeing wools, even though it had acquired the name of *Isatis tinctoria* and the coloring extracted was now classed as an indigotin. Among inorganic colors he might mention ultramarine, which, instead of being patiently produced by the careful treatment of *lapis lazuli* and sold at many shillings an ounce, was now manufactured by the ton and quoted by the hundredweight. Would that the artificial color was as fine and permanent as the natural. Not only coloring matters, but our flavors and scents had been synthesized, though art, if superseding nature for a time, must eventually acknowledge her inferiority, even in pear drops.

Sugar next came in for consideration, and though refraining from speculating on the future of "saccharine," the development of the sugar beet industry was emphasized and its ultimate bearing indicated. The study of micro-organisms and the process of fermentation had, by establishing the close relationship of chemistry and biology, rendered great assistance to the medical profession and the brewing industry.

Now that so many diseases had been traced to pathogenic organisms which were constantly present in water contaminated by sewage, the questions of the vitality of these organisms and their germs had been rightly regarded as one of great public importance, and the Royal Society, in conjunction with the London County Council, had instituted an investigation into it, which was being diligently prosecuted both from the botanical and chemical points of view. The remarkable power of light, whether that of the sun or electric, in sterilizing the germs of some micro-organisms, already to some extent previously known, had been conclusively demonstrated by Professor Marshall Ward. Much had been done of late years by chemists toward the *purification of sewage*, and the results obtained had been in many instances satisfactory. They would, no doubt, have been even more so had not the imperative demands of economy limited the cost. He would not attempt to discuss the important question of the disposal of sewage, but to many it would appear as somewhat of a disgrace to their powers of applying chemical knowledge that such vast accumulations of what were originally highly fertilizing substances should be not only absolutely wasted, but converted into a perpetual nuisance. It was true that within the last fifty years they had imported enormous quantities of guano, phosphates, and nitrates, but of these there must eventually become a scarcity, if not an end. In the meantime, might not chemists do something to reduce the waste of fertilizing agents that was now taking place among them? Agricultural colleges had been founded—*agricultural chemistry* was a recognized branch of science; but with increase of knowledge had come increase of foreign competition, fostered by improved means of transport and communication, and it was at the present time a doubtful point whether many soils, even if rent free, could be cultivated in this country for cereals, except at a loss.

In conclusion he said they were assembled on the borders of two of the greatest centers of the chemical industry, which had received them with open arms, and provided an "open sesame" enabling them to visit many interesting works, and he was sure they would not forget that they were all members of one body, and all mutually interested in the advance of chemical knowledge, and especially of chemical industry.

Among the works which were visited, were those formerly known as Sullivan's and Pilkington's, which have since been merged into the United Alkali Company, Ltd.

There are many interesting operations to be seen in progress at these works. In addition to the usual processes, such as the manufacture of vitriol, caustic soda, soda ash, and soda crystals, there are also the following to be seen: The production of saltcake, by Hargreaves' process; the preparation of monohydrated sulphuric acid, by G. Lunge's method; the Chance sulphur recovery process, which is a pretty piece of apparatus to see at work; while lastly, though by no means of least importance as regards interest, two rather rare articles are likewise manufactured, namely, chromic acid, which is now extensively used for voltaic cells, and strontium hydrate, so largely used in the sugar beet industry.

SALTS OF SULPHOPHOSPHORIC ACID.

A CONSIDERABLE number of metallic salts of sulphophosphoric acid H_3PS_4, have been obtained in a pure state by Dr. Glatzel, of Breslau, and are described, *Nature* says, in the current number of the *Zeitschrift fur Anorganische Chemie*. They are prepared by heating an anhydrous mixture of the chloride or sulphide of the metal with phosphorus pentasulphide, being produced in accordance with the equations:

$$3RCl + P_2S_5 = R_3PS_4 + PSCl_3,$$
$$3R_2S + P_2S_5 = 2R_3PS_4.$$

The metallic chloride or sulphide requires to be perfectly dry, if possible being fused previous to the experiment. When cold it is finely powdered, intimately mixed with excess of anhydrous pentasulphide of phosphorus and the mixture heated in a small retort, at first slowly and carefully, finally to low redness. If the chloride of the metal is employed, thiophosphoryl chloride distills over and is condensed in a receiver. The excess of phosphorus pentasulphide sublimes into the neck of the retort, leaving the metallic sulphophosphate behind. The latter is purified from any undecomposed metallic chloride or sulphide by washing first with dilute hydrochloric acid, and afterward with water, filtering and drying. In this manner the normal sulphophosphates of manganese, zinc, ferrous iron, nickel, cadmium, lead, thallium, tin, copper, silver, mercury, bismuth, antimony, and arsenic have been obtained in a pure state.

In addition to these, normal potassium sulphophosphate K_3PS_4 has also been obtained, but it was found impossible to separate it entirely from phosphorus pentasulphide; efforts to prepare normal sulphophosphates of sodium, ammonium, barium, strontium, and calcium have not yet been successful. The normal sulphophosphates of manganese, zinc, ferrous iron, nickel, cadmium, and copper were obtained in the form of crystalline powders, the others as fusible solids, which crystallize upon resolidification. The zinc and cadmium salts are white, the manganese salt green, the iron, nickel, lead, tin, and bismuth salts vary from dark brown or gray to black; the thallium, copper, silver, antimony, and arsenic salts are yellow; and mercury sulphophosphate is red and very sensitive to light. The whole of them, with the exception of the potassium salt, are insoluble in water and organic solvents, but

are slowly attacked by dilute acids with evolution of sulphureted hydrogen.

The potassium salt is decomposed by water alone with liberation of the same gas. It would appear, indeed, that the more negative metals, such as bismuth, antimony, and arsenic, form sulphophosphates with the greatest facility. The bismuth salt $BiPS_4$ remains in the retort after distilling a mixture of bismuth chloride and phosphorus pentasulphide as a dark-colored liquid which solidifies to a gray mass upon cooling, and yields upon pulverization a powder of the color of red phosphorus. Antimony and arsenic form similar crystalline sulphophosphates of a yellow color, which are more volatile, however, and, moreover, may be distilled without decomposition. The arsenic salt solidifies in the receiver in a transparent form resembling amber.

In attempting to prepare a ferric sulphophosphate by the action of phosphorus pentasulphide upon anhydrous ferric chloride, an unexpected artificial synthesis of iron pyrites, FeS_2, in crystals identical with those found in nature, was effected. The reaction occurs as represented by the equation:

$$3Fe_2Cl_6 + 2P_2S_5 = 3FeCl_2 + 3FeS_2 + 4PSCl_3.$$

The crystals of iron pyrites were formed as a beautiful glistening sublimate just above the heated portion of the retort. They possessed the usual brass-yellow color and brilliant luster, and consisted of pentagonal dodecahedrons and cubes or combinations of these forms, together with faces of the octahedron and of the more complicated forms of the cubic system. Moreover, the same mode of striation was observed as is so characteristic of natural crystals.

NEW VALUATION METHOD FOR RAW SUGAR.

THE usual method of determining the value of raw sugar—subtracting five times the ash from the polarization—has proved to be less satisfactory during the last few years, since it favors the tendency to reduce the amount of ash in any manner as much as possible, without having any regard to the organic impurities present. Since these organic substances also form molasses, without their action being taken into account in the commercial mode of determining the value of the sugar, it follows, says the *Chemiker Zeitung*, that the number obtained as above becomes less and less a true representation of the value of the sugar, as these substances increase in relation to the ash. On the contrary, the greater the yield paid for, or the better the sugar has appeared to be, the less has been the practical yield. After several years' negotiations with a committee chosen by the Society of Beet Sugar Industry, which unfortunately fell through, the Society of German Sugar Refiners has thought it necessary to issue a resolution on its own account aimed against this ever-increasing evil. It has decided after July 1, 1893, to purchase raw sugar only upon a new "yield" which is determined by subtracting from the polarization 2¼ times the total non-sugar. The number 2¼ has certainly no scientific meaning, but practically has two great advantages: in the first place it is the mean between the amount of non-sugar as actually present when the old method of calculation was introduced (1 ash + 1 organic matter=2) and that present in the sugar worked in the German refineries in 1891-92 (1 ash + 1·5 organic matter=2·5), which proportion moreover has since increased. In the second place, normal sugar which contains not more than 1¼ organic for one of ash comes out by the new method the same as before, since 1 × 5 is almost exactly the same as 2¼ × 2¼ = 5 (approx.) Sugars which contain more than 1¼ organic to 1 of ash come out worse, those which contain less better than before. As a matter of fact, every refinery will willingly pay as much or more for a high yield, when they know that they really get something for their money, while hitherto the statement of yield on which the sugar was bought stood in no practical relation to the amount which could be actually realized in the works. The statement that the new regulation has been adopted with the object of lowering prices is therefore completely erroneous, more especially since the present price is entirely determined by the position of the general market. It is, however, intended that in future only such sugars shall obtain a higher price which actually hold out a prospect of a higher practical yield; *i. e.*, the purchaser wishes to obtain actual value for his money. During the last few years it is just this point which has proved deceptive, and the demand for a change to a more stable state of affairs is thoroughly justifiable.

GILDED PLATINUM.

By W. C. HERAEUS.

THE author, in writing upon this subject, says, in the *Chem. Zeit.*, some thirty-eight of the apparatus constructed by him are already in use, eight of them being in England and America. According to the experience hitherto gained, the loss of weight of the completely gilded apparatus is not only seven times, but from twenty to forty times less than with the old platinum apparatus. It is essential for such a result that the whole of the interior surface of the still be covered with gold, for only in this way is the full advantage of the gilded platinum to be attained. In the upper part of the apparatus, which is not touched by the acid, the layer of gold may be quite thin. It has proved to be unsatisfactory to stop the layer of gold exactly at the surface of the liquid, because the nearest portions of platinum become moistened with the boiling acid and are much attacked, so that differences of thickness soon arise. On the other hand, Faure and Kessler pans, gilded as far as the lute and Delplace apparatus, in which the gilding is carried only a few centimeters into the upper portion, have lasted very well. The Faure and Kessler pans, as described above, have already been introduced into many works. According to the experience gained at the chemical works at Griesheim with a Prentice apparatus completely covered with gold, and which is used almost exclusively for the production of ninety-eight per cent. acid, the apparatus will work for at least fifteen years before requiring a new bottom, while a platinum still would require similar repairs at the end of a year and a half. As regards the economy of the apparatus, it is of importance to note that a considerable amount of the gold which goes into solution is deposited in the metallic form as a red powder in the platinum exit tube. If it were possible to collect the whole of the gold in this form, no loss of material would have to be feared. The preparation of ninety-eight per cent. acid, which has been undertaken in so few works on account of the great wear of apparatus, can now, however, be carried out without trouble.—*Chem. Tr. Jour.*

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